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THE GAS JOURNAL

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EDITORIAL NOTES

Vindication

In more than one respect the Autumn Research Meeting of the Institution of Gas Engineers held in London last week was the most successful of the three which have now been staged, and there can remain no doubt whatever of the wisdom of separating presentation and discussion of research reports from the general business of the June Annual Meeting. We cannot recollect a keener or more satisfying series of discussions—thanks largely to the fact that those who presented the reports carried out their task briefly. This was a much-needed reform, and the benefits were immediate. Then this year there has been a wholly admirable innovation. For the first time what is termed a " private report " was submitted, on behalf of Watson House, by Messrs. Masterman and Dunning. It is to be hoped that this plan is now established as part of the annual programme, for such accounts of work undertaken by individual gas undertakings constitute a natural corollary to the more general investigations of the Joint Research Committee of the Institution and Leeds University.

Taking into account that the meeting had to be postponed owing to the General Election, and also considering the state of national and world affairs, the attendance at the Institution of Mechanical Engineers was exceedingly gratifying; and it must have been a keen disappointment to the President, Mr. J. H. Canning, to be unable, owing to indisposition, to take the chair. Our readers will be glad to know that Mr. Canning is now well on the road towards recovery of health. In the circumstances the Senior Vice-President, Mr. R. E. Gibson, was called upon at a few hours' notice to preside over the meeting, and he performed his duties admirably.

Research—and Reforms

Throughout, the discussions were of a high standard; and at the close of the meeting everyone must have realized more than ever before that the progress of the Gas Industry is dependent on research—that money expended in this way yields full reward. And we were more than pleased that at the opening session this matter was fully ventilated. The question was actually raised whether the Institution, and therefore the Industry, was deriving sufficient benefit from research work at Leeds University. We think that the speech of Mr. Thomas Hardie, Chief Engineer of the world's largest Gas Undertaking, provides sufficient answer to the question, and we feel that it would be quite pointless for us to take up the cudgels in support of a cause which is already won.

Some comment on the research work of the Industry is, however, desirable, for certain aspects of the work should be made clear, and remembered. In the first place, Committees set up by the Institution decide what lines of investigation should be followed at Leeds University. By their nature, these Committees speak for the Industry; the research staff at Leeds work under their direction. The responsibility for the research and the manner of its presentation therefore rests with the Institution; and it is quite unfair to saddle Leeds University with this responsibility. By all means let members of the Institution criticize the outcome of this research; the results are put forward as targets. But, by now, it must be obvious that the accuracy of Leeds work is of an exceptionally high standard. The work is carried out patiently and thoroughly by men specially skilled. Moreover, it is extremely important work. Take, for instance, Mr. Wood's reports on carbon monoxide and oxides of nitrogen in the products of gaseous combustion. They embody results which are liable to attack by the whole medical world and by all competitive forces. That they can withstand this attack is to the credit of Leeds University and of the Gas Industry. Again, the research work at Leeds forms a basis for investigations such as that described by Messrs. Masterman and Dunning.

We ought to be quite clear in our minds about research work, and to differentiate between what may be termed fundamental research and industrial research. It would be the greatest mistake the Industry could make if Prof. Cobb were urged to concentrate more on industrial research and less on fundamental problems. No University has either the equipment or the facilities to carry out the work which can be, and is being increasingly, undertaken by industrial organizations. On the other hand, the latter have neither the time nor the inclination to do fundamental research, though they well appreciate its value and are the first to act upon its findings. Leeds University then, to our mind, has a very definite, a very necessary, and a very important sphere of action.

For a moment, however, let us consider the presenta-

tion of the research work of the Joint Committee of the Institution and Leeds University. A few years ago we did not have summaries of this work. We have them now—a great improvement. In this connection the "JOURNAL" pointed out that the reform was desirable. We now suggest that consideration should be given to further reforms. To-day the whole of our Industry must have faith in research. We refuse to believe that even the humblest engineer and manager does not desire the progress of gas and does not share the view that research is essential to this progress. It is unreasonable, however, to expect him to be concerned about every detail—all the niceties of method and calculation, and so on. Frankly, he does not require the full detail of procedure—detail which constitutes the bulk of the reports as at present issued by the Institution. This detail is absolutely necessary to those who are contemplating similar research, either in the Gas Industry or in other fields, either in this country or abroad; and it must be available. The only point we have to make about it is that perhaps some less expensive (we will not say theoretically better) way could be devised of rendering this detail available to those who want it. After all, it is material for discussion round the research table.

We have only one other observation to make. Is research work really so mechanical as to yield with unfailing regularity, at the end of each span of 365 days, results which it is necessary to publish *in extenso* for broadcast distribution, having regard to the wise outlay of time and capital? The solution to this query, we think, lies in faith in research.

Variety

IT is not our intention here to enter into any detail concerning the reports submitted at the meeting, for the entire proceedings are, as usual, dealt with in our "Review," which running commentary offers the reader a composite picture of what took place. The variety of the subjects of current importance discussed, and the wealth of suggestions put forward by contributors to the discussions as well as in the reports themselves, remain, however, as our dominant impression of this research meeting. So many of the views advanced are capable of immediate application to every gas undertaking, irrespective of size. Take the Report of the Street Lighting Committee, for instance. Means are described by which any undertaking, at very little expense, can vastly improve the public lighting in its area. Or consider the report submitted on behalf of Watson House. Here again, any undertaking can apply the simple rules, set out at the conclusion of the report, to ensure that the gas appliances fitted will be wholly satisfactory and hygienic in use. Then there is the First Report of the Liquor Effluents and Ammonia Sub-Committee—full of practical hints for every gas engineer and manager. And on general questions the meeting must prove of incalculable worth. The last nail has been hammered home in the coffin of the carbon monoxide bogey; and no one need have the slightest apprehension as to the hygiene of gaseous combustion as far as the production of oxides of nitrogen is concerned. Then it has been proved that creosote can be used successfully as an enriching agent in the manufacture of carburetted water gas, though its use in this manner is not warranted by market conditions, and is certainly unlikely to be justified in the future. The potentialities of creosote as a fuel for Diesel engines and internal combustion engines of the spark-ignition type were brought out, and it was clearly demonstrated what a suitable raw product creosote is for hydrogenation into motor spirit. And—quite a different subject—we gained a fresh viewpoint on carbonization and steaming in continuous vertical retorts. The items cited here—and we could advance many more—alone provide ample proof of our contention that the research meetings of the Institution are essential to the progress of the Gas Industry, and that anyone responsible for the conduct of a gas undertaking is failing in his duty if he does not pay close attention to the views expressed and the findings put forward at these meetings.

Gasholder Sub-Committee's Important Recommendations

Inspection and Insurance of Gasholders

As our readers are aware, the Gasholder Sub-Committee of the Institution of Gas Engineers has had under consideration proposals which have been made for the inspection and insurance of gasholders under contract, which matters arose from communications received from members and others interested as a result of the issue by the Council of its letter of Oct. 31, 1930, to members relative to the necessity for the periodical inspection and maintenance of gasholders and the keeping of a systematic record thereof.

At a meeting of the Sub-Committee yesterday, it was resolved to advise the Council of the Institution to recommend, where local conditions and circumstances make it advantageous for gas undertakings to provide by contract for the inspection and insurance of gasholders, that such inspection and insurance should conform with Model Conditions approved and issued by the Institution, which Conditions the Gasholder Sub-Committee should proceed to draft for the consideration of the Council.

Damage by Aircraft

The Sub-Committee has also had under consideration the question of the possibility of damage being suffered by undertakings from aircraft, and at the meeting of the Sub-Committee yesterday, it was resolved to advise the Council of the Institution to recommend that undertakings in the vicinity of an aerodrome, or situated in proximity to a recognized air route, should insure against this risk, and that the Sub-Committee should consider if cover against such damage could conveniently be included in the proposed policies for the inspection and insurance of gasholders.

Buy British—and Best

IT was our pleasure, in last week's issue of the "JOURNAL," to publish particulars of a special publicity campaign in the interests of British trade which is about to be undertaken by the Empire Marketing Board. The campaign is to open next Monday, with the support and co-operation of Government Departments and the leading national associations representative of British manufacturers, trade, and commerce, and it is one in which the Gas Industry should take a full share. To render this assistance it has, fortunately, the means right at hand.

Practically every gas undertaking possesses a showroom—many of them two or three, and some half-a-dozen and more—and each showroom has windows, in which can be made an effective display of the special advertising material available for the purposes of the campaign. There could be no more suitable place than a gas showroom window for the display of the appeal, for our Industry is a British one, and a loyal and patriotic one at that. Determine, therefore, immediately to aid this effort on behalf of British trade and employment. Specially designed posters for the purpose are available in crown and double crown size, and can be obtained at any Employment Exchange or Local Employment Office.

The Example of Tar

THE slogan "Buy British—and Best" inevitably brings to the mind of anyone associated with the Gas Industry the subject of tar. Tar is certainly British, and it claims to be best, for the purpose for which it is now so largely used. The day when everybody and everything will "take to the air" is too far away to call for serious consideration at the present time. Roads there are, and roads there will be; what has to be done is to provide the best possible. Here it is that the British Road Tar Association steps in, and steps in effectively. Under the Presidency of Sir David Milne-Watson, it has done, and is doing, most valuable work. During the

past year or so, too, it has had further great assistance from Mr. R. G. Clarry, the newly elected Member for Newport (Mon.), as Chairman.

The British Road Tar Association has just held its fourth annual meeting, and the address of the President on that occasion, which will be found in this issue of the "JOURNAL," deserves careful study by all who desire good roads. As Sir David urged, there is doubtless need for a better understanding of the inherent possibilities of the national resources of the country to fulfil our road-making requirements, and the Association is doing invaluable work in securing this better understanding. Mention has already been made in our pages of the Association's talking film entitled "Coal Mine to Road," the principal object of which is to give pictorial emphasis to the fact that we have in this country an all-British product derived from British coal, the production of which gives direct employment to nearly 200,000 British workpeople in the gas, coke oven, and tar distilling industries, and indirectly as well to 800,000 miners. The film is a reminder that British tar, stone, and slag are available in all parts of the country, and when, therefore, local authorities build and maintain roads with these materials, not only is work being provided for their own local workpeople, but at the same time their use is giving a welcome fillip to local industry. Perhaps most important of all, the money expended is being kept in this country.

But Sir David is always careful to point out that propaganda is only one side of the Association's work; it has another, and equally important, aim—the improvement of the product and the exploration of new developments which can be placed at the disposal of road authorities throughout the country. On this side, also, notable progress fell to be reported. British Standard Specification for Tar No. 3 has been issued, the object being the production of a tar which would facilitate quick setting; and progress has been made with other specifications. The Technical Committee has continued its work of investigation, and the preparation of demonstration stretches of road has been a prominent feature of the year's operations. The President also referred to the creation, at the invitation of the Department of Scientific and Industrial Research, of a Special Road Tar Research Committee, under the Chairmanship of Sir Robert Robertson, Government Chemist. Under this arrangement, research work on road tar and road problems, in so far as they concern tar, will be carried out by the expert staff of the Department, and the Association looks forward, through this work, to rendering a further service to the road industry of Great Britain.

The Association is carrying out essential work that is of benefit alike to buyer and to seller, and all tar producers should identify themselves with it. The President made an appeal for the whole-hearted support of the coke oven industry which we hope will be heeded. Any undertaking not subscribing to the Association should do so. All should support that by which all benefit.

A *Revolution in Gas Fire Construction*

A GAS heating development of the greatest importance is described in our issue to-day—a development which will soon be the talk of the country. Radiation have brought out a gas fire of remarkable design and possessing such attractive qualities, from the dual point of view of hygiene and comfort, that it is certain to meet with a wide public appeal, just as it is certain to gain the approval of our Industry. This new fire is definitely a fire of distinction, and we believe that it will help the gas heating load greatly.

The Gas Industry certainly owes a great deal to the research work undertaken by Radiation, ever since its inception, to the high standards of design, workmanship, and performance of the gas-using apparatus marketed by the firm, and to the enlightened policy of national publicity which has always characterized its work. The production of the fire described to-day is a typical example of the methods of Radiation; it is the outcome of patient, prolonged research at the Central Laboratories and the skilled application of accumulated experience. For many years past Radiation have concentrated on improving the quality of the radiant energy emitted by the gas fire—increasing the emission of short infra-red energy. They experimented with materials for radiants and with other materials for treating radiants, and the results were embodied in the "Beam," which hammered home the last nail in the coffin of the "scorching bogey." But they did not rest content with this, though it was a marked improvement. It was, in fact, this very improvement which made it obvious that a radical change in gas fire construction was necessary if the full virtues of short infra-red energy were to be exploited. Development of ideas on the subject led to the "Cobble" "Beam" fire, which was demonstrated to us a week ago.

We were impressed most favourably by the virtues of the "Cobble" "Beam." It has a restful appearance; the heat it emits is exceedingly comfortable; it employs semi-luminous flames as distinct from the bunsen flame; and this results in a completely silent fire and, of course, absence of any risk of "popping-back;" the construction of the fire is such that "sideways warmth" is obtained; the emission of short infra-red energy is greatly increased; its ventilating capacity is equal to that of the firm's "Injector-Ventilator" fires, and it is remarkably simple to fix. Finally, the fire is something entirely new, and is obviously calculated to arouse widespread interest and to make the general public realize that our Industry is essentially alive. Without wasting words, we welcome the "Cobble" "Beam."

Water Gas Manufacture

OUR readers will be interested in an illustrated description, appearing on later pages of this issue, of a completely automatic water gas set which has met with much success in the United States, and is now being built in this country. Several features of the system are attractive, in particular the flexibility of the unit controlling the cycle, which is operated entirely with oil under pressure. Timing valves are provided on the control to govern the cycle. The latter is split up into short subdivisions, and each timing valve controls the length of time required in that sub-division of the cycle. The timing device, which is easily adjusted, permits the use of any length of cycle required in the operation of the generating set. As for the charger, this appears to be highly effective and foolproof. The mechanical grate is characterized by the fact that it is flat. A cast-steel beam, with its working face up-stroking and out-stroking, revolves slowly around the grate, and the chief claim made in its favour is that it maintains horizontal uniformity in the fuel bed. Though no plant of this type is at present operating in this country, it is significant that the unit which we describe to-day is one of four having a total capacity of *circa* 16 million c.ft. of water gas per diem.

Forthcoming Engagements.

Nov. 13.—GAS COMPANIES' PROTECTION ASSOCIATION.—Annual Meeting. Caxton Hall, at 2.30. Meeting of the Committee following the General Meeting.

Nov. 17.—INSTITUTION OF GAS ENGINEERS.—Institution Session at the 6th Public Works, Roads, and Transport Congress and Exhibition, 1931, 11 a.m.

Nov. 18.—B.C.G.A.—Meetings of Executive and General Committees at 11.30 a.m. and 2.30 p.m. respectively.

Nov. 19.—S.B.G.I.—Council Meeting and Autumn Meeting at the Hotel Metropole.

Nov. 19.—B.C.G.A.—District Conference at Swansea.

Nov. 20.—INSTITUTION OF GAS ENGINEERS.—Liquor Effluents and Ammonia Sub-Committee, 2.30 p.m., 28, Grosvenor Gardens, S.W. 1.

Nov. 20.—LONDON AND SOUTHERN DISTRICT JUNIOR ASSOCIATION.—Meeting in London.

Nov. 24.—SOUTHERN ASSOCIATION OF GAS ENGINEERS AND MANAGERS (EASTERN DISTRICT).—Meeting.

Nov. 25.—SOUTHERN ASSOCIATION OF GAS ENGINEERS AND MANAGERS.—General Meeting, Hotel Metropole, W.C., 2.30 p.m.

PERSONAL

Following on the General Election, the Ipswich municipal elections resulted in a landslide against Labour, for they lost five seats and gained not one. In the St. Clement's Ward, Mr. G. A. MALLETT (Secretary of the Ipswich Gas Light Company) headed the poll as an Anti-Socialist. The ratepayers have chosen well.

OBITUARY

MR. A. C. IONIDES.

Many of our readers will remember the research work in fuel economy and the taking out of numerous patents for a new system of firing with gaseous fuels by Mr. ALEXANDER CONSTANTINE IONIDES, whose death occurred in London on Nov. 2.

Writing in "The Times" of Nov. 7, Mr. J. W. Gordon, K.C., who was hon. chemical adviser, Ministry of Munitions, says of Mr. Ionides:

After a successful career on the Stock Exchange he retired at an early age and devoted his leisure to literary and scientific studies. In both directions he followed the bent of his own mind, but always with an eye to the public value of the work in which he engaged. It was this regard for practical ends that led him to take up the study of fuel economy and occupy himself in a research in which he spared neither trouble nor money. His technical success was not incommensurate to his effort, and when, during the war, we were feeling the pinch in our coal supplies, he was able to point the way to important economies which at one time promised great things.

Attractive offers to purchase his patent rights were made to him and rejected, for he was resolved that his work should not be made the basis of a great monopoly, but be placed at the service of the public in such wise as to promote the greatest good of the greatest number. Himself a sturdy individualist, he perhaps over-estimated the ability of manufacturers to adopt new methods of working and under-estimated the coercive power of use and wont. A brilliant initial success was followed by a disappointing sequel. Workmen, of course, objected to labour-saving devices; employers found themselves confronted by opposition of the kind which they least like to encounter; and when the excess profits duty made the saving of working costs in industry an unprofitable enterprise his plans became unworkable; his great ambition faded out of view. He held on so long as life and strength remained to him.

He was a member of the Royal Institution, the Royal Society of Arts, and the Aristotelian Society.

CORRESPONDENCE

A Grateful Acknowledgment

SIR,—May I make use of your columns to tender to the very many representatives of the great American Gas Industry whom I had the pleasure of meeting and greeting at Atlantic City and elsewhere in the States and Canada during October my very grateful thanks for the unbounded kindness, courtesy, and goodwill which they extended to my wife and myself throughout that never-to-be-forgotten three weeks? I ask this because so many people did so many kind things (behind the scenes as well as before them) without in many cases giving us an opportunity of even saying "Thank you;" and only in this way can I hope to make them realize how much their kindness was appreciated.

I am glad that, at the same time, I can repeat to others the very cordial thanks already inadequately expressed to them in person for the amazing generosity and friendliness experienced at their hands. If, as I believe, riches consist in the abundance of friends, I am happy to feel that, despite the dearness of the dollar, I have come back deeply enriched from what was my first, but, all being well, will certainly not be my last, visit to that hospitable land.

FRANCIS GOODENOUGH.

British Commercial Gas Association,
28, Grosvenor Gardens, S.W. 1,
Nov. 10, 1931.

"Buy British"

SIR,—The writer has received from the Empire Marketing Board a communication asking for publicity for posters, &c., advising everyone to "Buy British."

For some time back this gas undertaking has had difficulty in getting suitable cheap glassware of British make. Although it may be true that British firms supply glassware of superior quality, we are of opinion that they have not catered for the requirements of the working classes in this direction, and it has therefore been necessary for us to stock cheap foreign globes, which has lately brought upon us some severe censure. The writer maintains that the public are the best judges of what their pockets can afford, and the fact remains that, if gas showrooms refuse to supply these cheap grades of globes, then the business goes to a firm who for a number of years have provided the working classes with almost anything at cheap rates.

My principal reason for troubling you with this communication is the fact that the circular from the Empire Marketing Board, already referred to, states that the British Commercial Gas Association, the British Chambers of Commerce, and the Federation of British Gas Industries, are all interesting themselves in the campaign, which will begin on Nov. 16; and it might be wise that one or other of these bodies communicate with the Association representing the British glassware manufacturers with a view to finding whether something can be done to provide this cheap glassware, because it must be recognized that, however willing one may be to encourage Home Industries, this particular industry does not appear to have done all it can to discourage the importation of glassware.

"OPAL AND CLEAR."

Nov. 9, 1931.

Hydrogenation of Coke Oven Gas

SIR,—Mr. Sensicle, in a letter published in the "JOURNAL" of Oct. 21, attacks a statement made by Dr. Ormandy in his paper before the Institute of Fuel as to the amount of hydrogen necessary for the production of petrol by hydrogenation. Dr. Ormandy's figure is, of course, definitely correct, as it includes the amount of hydrogen transformed to hydrocarbon gas. The balance between 100 p.ct. of coal treated and the 60 p.ct. by weight, which is recovered as petrol, is made up of water, ammonia, and sulphuretted hydrogen derived from coal, and of hydrocarbon gas, the amount of solid residue being only about 3 p.ct.

The hydrocarbon gases are, of course, utilized for the production of the hydrogen required, not as suggested by cracking, but by catalytic treatment by steam. In this process not only the hydrogen itself is recovered, but the carbon contained in the hydrocarbon gases is utilized to decompose steam to give a further quantity of hydrogen. Although the hydrogen used for ammonia synthesis at Billingham is prepared from water gas made from coke, we are contemplating in our schemes for petrol manufacture producing all the hydrogen required from hydrocarbon gases.

The utilization of coke oven gas hydrogen for hydrogenation has been in our minds for some years, but has been rejected because of its impracticability for the large scale. If we imagine a plant producing 200,000 tons per year of petrol, which we consider the most suitable sized unit, we should have to buy 85,000,000 c.ft. per day of coke oven gas, to make which must be coked 7000 tons per day of coal. The total residual gas including both the hydrocarbons removed from the coke oven gas, and the gas produced in the hydrogenation process, will be 47,000,000 c.ft. per day, which has a total heat value approximately identical with the original coke oven gas. In order to secure the quantity and price we require, all the coke ovens in the South Yorkshire Coalfield (for example) must deliver all their gas to the hydrogenation plant, which must return to each of them sufficient surplus gas for firing its own ovens, but the balance of gas having a considerably higher calorific value than coke oven gas is still to be disposed of.

K. GORDON.

Imperial Chemical Industries, Ltd.,
Millbank, London, S.W. 1,
Nov. 4, 1931.

THE NEWS OF THE WEEK

The "Punch" Almanack is a gay and irresponsible publication. It is brilliant in colour and in matter—it is a real antidote to the prevailing depression—and costs 1s.

A New Scale of Charges is being introduced by the Greenock Corporation Gas Department as from Nov. 16. In the new scale the reduction in price from 7·25d. to 7d. per therm will come into operation for consumptions of 5000 c.ft. per quarter instead of 10,000 c.ft. as in the previous scale.

Good Propaganda is provided by the publication of two attractive booklets containing the addresses of Sir Banister Fletcher, F.S.A., and Dr. L. Meredith Davies, M.A., presented at the Twentieth Annual Conference of the B.C.G.A. at Exeter last September. The former, as will be remembered, was on the subject of "Architecture as a Democratic Art," and tells of the part gas can play in house planning, while the other was entitled "Public Health and the Gas Industry."

New Gasmaking Plant and the reconstruction of a gasholder is to be undertaken by the Gainsborough Urban District Council. A deputation of the Chairman of the Gas Committee, one Councillor, and the Gas Engineer and Manager, Mr. C. E. Byrt, are to inspect various types of horizontal and vertical retort installations with a view to deciding which will be the most suitable for their requirements. The existing carbonizing plant consists of stop-end retorts and hand-charging, and it is estimated that a considerable saving will be effected in changing over to up-to-date methods.

Exhibition Houses have become a popular means of attracting attention to new gas appliances and convincing housewives of their particular suitability for the modern dwelling. That situated in Queen's Drive, Liverpool, which opened on Oct. 31, had the support of the Liverpool Gas Company, which supplied apparatus for almost every room. They have placed a "St. Bernard" 6-loop luminous radiator in the hall, a "Sunbeam" gas fire in stainless metal in the lounge; a "Dean" wash-boiler of 12 gallons capacity in the wash-house; and a "Cambridge" gas cooker, complete with plate-rack and "Autimo" heat regulator in the scullery.

"Buy British" Boom.—Further evidence is forthcoming of the extent of the world's new interest in British goods. An inquiry for a complete gas-works for a town of 300,000 inhabitants in Greece is among hundreds of communications received from potential buyers of British goods in twenty countries overseas as the result of a new information system adopted by the British Industries Fair in Birmingham. The new system has involved the compilation, now nearing completion, of an alphabetical card index consisting of the names of some 10,000 articles manufactured by firms which will exhibit in the Fair at Castle Bromwich next February.

Cheap Gas to Help Industry.—With a view to encouraging the greater use of gas in local industries, and as some little contribution to the general effort to revive trade in Bradford, the Bradford Corporation Gas Committee have approved a valuable concession under which the minimum price for gas for large consumers—irrespective of purpose—is to be 1s. 6d. per 1000 c.ft., instead of the existing minimum of 2s. 6d. for ordinary purposes and 2s. 2d. for industrial uses. It is expected that the concession will result in a drop in revenue of about £1500 per year at first, but hopes are based on its resulting eventually—by expansion of business—in material benefit both to the Department and to users by making gas fully competitive with every kind of fuel available.

Institution of Gas Engineers.

Members of the Institution of Gas Engineers are invited to attend the Chadwick Public Lecture on "Diet and Hygiene," which will be given by Mr. Gerald Slot, M.A., M.R.C.P., on Wednesday, Nov. 18, 1931, at 5.15 p.m., in the Lecture Hall of the Royal Sanitary Institute, 90, Buckingham Palace Road, Victoria, London, S.W. 1.

The Chair will be taken by Sir James Crichton Browne, M.D., F.R.S., LL.D., D.Sc. Tickets of admission are not required.

An All-British Glassware Showroom.

The accompanying photograph is of a portion of Messrs. Hailwood & Ackroyd's new London showrooms at 71-75, New Oxford Street, W.C. 1, where they claim to have the

largest display of entirely British-made glassware and lighting fittings in the country. It is all "Hailware" and is manufactured throughout at the firm's Head Office and Works, Morley, near Leeds.

East Hull Company's Annual Gathering.

Presentation to Engineer and Manager.

Each year the Directors and workpeople connected with the East Hull Gas Company assemble under social conditions, partake of tea, enjoy a concert and dance, and present to those employees who have completed a quarter of a century's service gold medals as a memento. They are always delightful gatherings, and that held recently at the St. Andrew's Parish Hall, Abbey Street, Hull, was more so than usual because one of the long service medals was presented to the Engineer and General Manager of the Company, Mr. Richard Nelson.

Mr. Nelson is extremely popular with all employees, and an expression of this popularity was voiced when he was presented, not only with the medal, but with an inscribed silver salver and a pair of gold cuff links from the employees. Mrs. Nelson was the recipient of a pair of gold and pearl ear-rings.

Mr. George M. B. Jalland (Chairman of the Company) presided.

Mr. Nelson, responding, said that the only reason he could think of why he had been presented with the charming gifts was because he had done his duty to the Company. In the whole of the years he had been connected with the undertaking it had been his object not only to serve the Company, but to try to make the lot of the employees as comfortable as it possibly could be. He emphasized the competition that they had in Hull, and said that 25 years ago, when the Company was known as the Sculcoates and Drypool Gas Company, the gas made per year was 193 million c.ft. Last year they made 650 million c.ft., an increase in the 25 years of 461 millions, or nearly three and a half times as much.

The competition they had to face to-day was becoming more and more difficult, and it was much harder to maintain the increases they had had during the past 10 or 15 years. He asked the employees and their wives to act as potential salesmen and saleswomen by talking and preaching gas on every occasion to their friends and neighbours.

As an old servant of the Company he gave some sound advice to the younger employees. He asked them not to be content with knowing simply their own job, but to get to know the job of the man above them, and to get to know all they possibly could about the whole business. The Directors were always willing and eager to recognize ability.

INSTITUTION OF GAS ENGINEERS

Review of Proceedings

at the THIRD AUTUMN RESEARCH MEETING held at the Institution of Mechanical Engineers on Nov. 3 and 4

PRESIDENT - MR. J. H. CANNING, OF NEWPORT

[Abstracts of the Reports presented were published as a Supplement to the "JOURNAL" dated Oct. 28; the discussions are reproduced verbatim in this issue]

The President's Misfortune.

Considering the anxious times through which the country has been, and is, passing, and the fact that, owing to the General Election, the Autumn Research Meeting of the Institution of Gas Engineers had to be postponed, there was a gratifying attendance on Tuesday morning at the Institution of Mechanical Engineers. When the meeting opened those present were surprised to find that Mr. Ralph Gibson, the Senior Vice-President, was occupying the chair instead of the President, Mr. Canning. Unfortunately, on the evening prior to the meeting Mr. Canning, who had arrived in London, contracted influenza, which necessitated his absence throughout the proceedings on both days of the meeting. A message of sympathy expressing the good wishes of the members assembled was sent to Mr. Canning, and when the meeting concluded on Wednesday afternoon it was good to receive the intimation that Mr. Canning was progressing favourably towards recovery of health. It must have made the President very unhappy not to be able to preside over a meeting which was singularly successful and marked by such keen and valuable discussions. However, in Mr. Gibson, who at very short notice agreed to occupy the Chair, he had a worthy substitute.

There can now be no doubt whatever of the wisdom of holding Research Meetings apart from the Annual Meetings in June; also there can be no doubt that the time spent in discussing the communications as distinct from the time spent in presenting them adds enormously to the benefit to be derived from any meeting of the Institution.

Education in the Industry.

The first communication to be presented and discussed was the Report of the Gas Education Committee, 1930-31. This outlines a satisfactory state of affairs, but one which could be made still better by greater co-operation of all gas engineers and managers, who are asked to draw the attention of their employees to the provisions of the Education Scheme. The report gives lists of successful candidates in both the 1930 and the 1931 Examinations—lists which have already been published in the "JOURNAL." The 1930 results in the Major Subjects show a slight decrease in the number of examinees as compared with the previous year, but the statistics relating to the 1930 Minor Course Examinations (conducted by the City and Guilds of London Institute, under the auspices of the Institution) demonstrate a substantial increase in the number of candidates.

Turning to the 1931 Examinations, there was an excellent increase—14 p.ct.—in the number of internal candidates taking the Major Subjects; and as for the Minor Course Examinations, the number of candidates for the Final Examination in Gas Fitting was considerably greater. Not only was there growth in numbers, however, for the Examiners explain that there was improvement in the standard of work in both the Higher Grade and Diploma Examinations in Gas Engineering. The report shows that seven additional courses in Major Subjects were approved during the year, and twenty-two additional courses in Minor Subjects. The number of applications for the approval of Minor Courses, particularly in Gas Fitting, is indicative of the increased interest which is being shown in the provisions made by the Education Scheme for the education and certification of craftsmen and others, many of whom do not wish to qualify for the professional side of the Industry.

There has been an increase in the number of candidates for the Examination in Gas Works Practice and 25 p.ct. more Approved Centres presented candidates in Gas Fitting than in the previous year. This indicates the tendency which exists for students to study internally at an Approved Centre, instead of acquiring their knowledge by other means. The advantage which a student gains by studying a Course at an Approved Centre cannot be too highly stressed, and it is satisfactory to see that this is being recognized.

The Education Committee, it should be noted, has decided that 1932-33 shall be the final session for the examination of candidates who have been accepted in previous years with qualifications which are inadequate under the existing Regulations; and in future permission to sit for an examination applies only to the next examination after such permission is given.

Towards Greater Utility.

As Sir Francis Goodenough was not present at the session, it fell to the lot of Mr. Gibson to submit this report, and we agree with his remarks that the reorganization of the Education Scheme administration will conduce to its greater effectiveness.

The first speaker in the discussion was Mr. T. H. Prater, the Secretary of the South-Eastern District Committee, who suggested that the most satisfactory features of the report are the large increase in the attendance at classes in Gas Fitting and the large increase in the number of centres at which approved tuition can be obtained. As he pointed out, our gasfitters are the people who come into direct contact with the consumers, and it becomes more and more important that these men should not only be efficient fitters, but should also understand the technical aspects of their work.

We Need Models.

Mr. J. G. Clark then spoke about the enthusiasm of the students themselves—a gratifying fact, and one which cannot help but inspire those who are responsible for

J. HERBERT CANNING,

Engineer and Manager of the Newport (Mon.) Gas Company.

Mr. J. Herbert Canning, O.B.E., President of the Institution of Gas Engineers, has been Engineer and Manager of the Newport (Monmouthshire) Gas Company since 1919, being the eldest son of the late Mr. Thomas Canning, who was Engineer and Manager of the same works for many years before him until his death in 1919. Mr. J. H. Canning was educated at Prior Park College, Bath, and subsequently studied engineering and science at the Technical College, Newport, where he was particularly successful. He was silver medallist in science in 1893 and gold medallist for the best record in science over the three years 1892 to 1895. In 1897 he was successful in gaining the first prize in the honours class, and the national silver medal awarded in connection with the examinations of the City and Guilds of London Institute. In 1915 he was appointed by the High Explosives Committee to organize and direct the work of providing high explosives in Wales and Monmouthshire, and was assisted by a committee of five gas engineers. He was appointed divisional officer (coke and gas) for the same area in 1918. He was made an Officer of the Order of the British Empire in 1920 for war services.

carrying out the aims of the Education Scheme. Already the good effects of this training are being felt throughout the Industry, and this happy influence will be enlarged as the years pass. In regard to teaching Gas Supply, Mr. Clark thinks that the Gas Education Committee might well consider providing instructors with suggestions or ideas, and equipment whereby the phenomena of Gas Supply could be demonstrated by means of models. He pointed to the distinction between the gas engineering student and the gas supply student. The former has so many opportunities of gaining information both on the works and in the laboratory. Gas supply men, on the other hand, have practically no chance of acquiring any manipulative skill in the laboratory which would enable them to handle apparatus designed to demonstrate the fundamental technique of their subject. However, the instructors are men who have already acquired skill in manipulating instruments, and there is no reason why this skill should not be imparted to the student by means of models. There is, in fact, everything to be said for this idea. Mr. Clark also commented on the fact that as yet no one had gained a Diploma in Gas Supply, and it is obvious that he believes that some change will have to be made in the planning of the Gas Supply Course. Between now and the next examinations the Institution will consider certain suggestions as to the guidance of gas supply students in obtaining Diplomas; but Mr. Clark does not seem very hopeful as to the outcome of this. A more radical change is needed. We regard it as being not merely desirable, but necessary, for the progress of our Industry that greater attraction should be offered and more encouragement given to gas supply students to spend the time and exercise the effort required for gaining the Diploma which opens the door of full membership of the Institution. This is an important, a pressing, problem.

New Diplomés.

Then came the presentation of Diplomas—all, of course, in Gas Engineering. The successful candidates who obtained First Class Diplomas were: H. Johnston, of Blackpool; A. C. Rea, A.M.I.Mech.E., of Edinburgh; and W. P. Smith, B.Sc., of Bolton. Second Class Diplomas were presented to J. C. Cotterill, of Worcester; J. R. Owen, of Richmond, Surrey; and B. Thorpe, of Huddersfield.

Mr. Rea was also presented with the Charles Hunt Memorial Medal in the Diploma Examination in Gas Engineering for 1931.

An Admirable Innovation.

Mr. Copp then presented the Second Report of the General Research Committee, 1930-31—the Committee which supervises and co-ordinates the research work of the Institution, and particularly that of the Joint Research Committee of the Institution and Leeds University, and of the Research Sub-Committees. It is mentioned that for the first time there is a contributed research report—the result of a decision of the Council of the Institution that private research laboratories should be permitted to submit reports for presentation to the Institution. The idea—which is heartily to be commended—is that the General Research Committee should co-operate more extensively with such laboratories and with undertakings and other organizations carrying out research work of general interest to the Gas Industry. During the year new Research Sub-Committees have been formed to deal with meters, street lighting, and tar. The administration of the work of the General Research Committee has been re-organized and, *inter alia*, arrangements have been made whereby members of the Committee and of the appropriate Sub-Com-

mittees are kept informed of the activities of other technical organizations. In particular, copies of relevant technical papers are circulated for information, and members arrange to participate in the discussion on such papers.

The report indicates the work of the Joint Research Committee, the various Sub-Committees, the Gas Research Fellow, and the "private" investigation. As we shall outline most of this work under separate headings, it only remains here to mention the investigations in regard to calorimeters, corrosion of pipes, gasholders, purifiers, and meters; the Sub-Committee on Tar has only just commenced its work. As to calorimeters, the research staff are going to examine one or more different types of recording instruments; and probably a report will later be issued for the guidance of gas engineers. Arising from the 1st Report of the Corrosion of Pipes Sub-Committee relating to the Protection of Pipes against External Corrosion, a number of protected tubes and protective coatings and devices have been submitted to the Sub-Committee for examination. A visit to Germany was made to inspect the manufacture and use of a protected tubing, and recent American and German literature on soil corrosion is under consideration.

Insurance of Gasholders.

As a result of the issue by the Council of the Institution of a letter to members as to the necessity for the periodical inspection and maintenance of gasholders and the keeping of a systematic record thereof, proposals have been made for the inspection and insurance of gasholders under contract. The technical considerations involved are under consideration by the Gasholder Sub-Committee, while attention is being given to other suggestions relative to the maintenance of gasholders and the precautions to be observed in their erection and repair. [In this connection see our Editorial Notes.]

The Meters Sub-Committee is continuing to consider, among other matters, the technical aspects of proposals for the periodical verification of meters, while the Purifiers Sub-Committee is collating data relative to accidents with purifiers, and continues to provide advice as to precautionary methods available for the avoidance of explosions, fires, and personal injuries. As a matter of fact, the number of such accidents is relatively negligible.

On the question of the inspection of gasholders Mr. Copp submitted that gas engineers are quite a capable body of men well able to examine the exterior of their holders to make sure that they are in proper working condition. The only thing they cannot do is to inspect the interior. He remarked that no Government inspector, however brilliant, could do this without emptying the tank; anybody, however, can do it when the tank is empty.

To our mind the most interesting observation made by Mr. Copp was his expression of hope that in future the results of the investigations of the Joint Research Committee of the Institution and of Leeds University should be translated into definite pecuniary advantage to the Gas Industry.

As Vice-Chairman of the Joint Research Committee Mr. Thomas Hardie pointed to the positive value of the work of the various Sub-Committees of the Joint Research Committee. Then came the discussion.

Col. Carr mentioned that suggestions for inspection of gasholders have been made recently by insurance companies. "Be that as it may," he remarked, "I suggest that it does not relieve the gas engineer from the primary responsibility for the maintenance of his plant. I feel that the schedule which was sent out to many gas undertakings under the name of an insurance company would have been better if it had first received the seal of investigation and approval by the Gasholders Research Sub-Committee." Gas undertakings must understand that the matter is being dealt with by the Research Committee, and no doubt a scheme will be forthcoming on which to work. It will then be for those who think it desirable as a secondary precaution to consider the question of insurance.

Industrial Gas Research.

A very useful suggestion made by Col. Carr was that the Joint Research Committee should consider the establishment of an Industrial Gas Research Sub-Committee. Much work awaits investigation—furnace atmospheres, conductivity and the melting of metal, and so on. And there is no doubt that there ought to be close co-operation between such a Committee and those concerned with metallurgical research. This idea is strongly supported by Dr. E. W. Smith, whose remarks were mainly directed to the application of research to the problems of the Gas Industry. If there is criticism of Leeds University it must be borne in mind that the Institution, through its Committees, approves of the problems which should be tackled, and of the personnel appointed. The Sub-Committees, he pointed out, are not cyphers; they are the consultants to the chemists. The chemists bring forward reports at the request of those Committees, and in the manner in which the Committees want the reports prepared. The application of the results of the researches lies in the hands of the Institution. In brief, it is up to the Research Committees themselves to help the chemists.

Research in Terms of £ s. d.

Mr. Thomas Hardie, in a stirring speech which was listened to with the closest attention, said that it is quite unfair to saddle Leeds University or Prof. Cobb with the responsibility for selecting the work which has been done or is about to be done. The responsibility is that of the Institution itself. "With regard to the value of the work of the Research Committee from its inception some twenty years ago," remarked Mr. Hardie, "if there is any member here who can say that it has not been of monetary value, then I shall be surprised. I myself have found it extremely valuable, and I can put into terms of pounds, shillings, and pence the advantages which have been obtained from many reports of that Committee."

Mr. Gibson said how helpful the summaries of the reports were. In his view, for the purpose of discussion and practical use, it is unnecessary to give all the minute details of the chemical and physical researches carried out, and he would like to see the reports written as concisely as possible, and with a clear and definite statement of the advances made and of the knowledge gained. The details are valuable for reference but not essential for the purpose of discussion at a general meeting of gas engineers. The point is that research work is a means to an end, and sight must not be lost of its ultimate object.

Prof. Cobb, who rose in defence of Leeds University and of the methods employed in presenting the results of research work, said that, in view of Mr. Hardie's remarks, his defence was a very easy one. The Joint Research Committee has a membership which is drawn almost entirely from the Institution, and this Committee decides the subjects of research to be undertaken on behalf of the Institution and with Institution funds; and its efficiency of work is ensured by the Chairmanship of Mr. Hardie and the collaboration of carefully chosen members. As to the reports, Prof. Cobb said that there was a general introduction giving an account of the results obtained. Then there was a brief summary, and this again was followed by a more extended summary. The wording of this more extended summary is brought before the Joint Research Committee and is finally considered by the General Research Committee. "How," asked Prof. Cobb, "would it be practicable to ensure a better summary than this?" Finally, there is a detailed account of the investigation—which is intended to be a detailed account to help those people who are carrying out similar researches or who are proposing to carry out research work of a similar character.

NO in Combustion Products.

The last item on the programme on Tuesday morning was the presentation and discussion of the 28th Report of the Joint Research Committee, which deals with the determination of oxides of nitrogen in the combustion products of free-burning flames. The Chemist in charge of this work is Mr. Wood. One of the reasons for undertaking this research is that many results reported for carbon monoxide in the past must have been rendered more or less unreliable by the unrecognized interference of oxides of nitrogen in the determination. It has been necessary to investigate closely what methods can be applied in order that these two constituents, carbon monoxide and oxides of nitrogen, can be determined separately and accurately. In previous reports the sources of error in the estimation of carbon monoxide have been examined carefully, a means

for its accurate determination ensured, and the results obtained by the application of the method to the products of combustion of typical gas appliances have been published. The same is now being done for oxides of nitrogen.

Another reason for the investigation is that oxides of nitrogen have slight toxic properties and an irritant action on the mucous lining of the respiratory passages; in addition to any corrosive action which they may themselves possess, they accelerate the oxidation of sulphur dioxide to sulphur trioxide in the presence of water vapour, and hence increase the corrosion of gas fittings and appliances.

However, the results demonstrate clearly enough that the amounts of nitric oxide produced by free-burning flames are very small indeed—about 1 part per 10,000 by volume only, in the "theoretical" products of combustion free from excess air, and correspondingly less in the diluted products calling for examination in practice. Hence no exception can be taken to them on hygienic grounds.

Turning for a moment to the methods of determination employed, two were examined—one due to A. R. Pearson, of the South Metropolitan Gas Company, and the other to Francis & Parsons, worked out in the Government Chemist's Laboratory. The former is a reduction method. A chromic-sulphuric acid reagent is used for absorption of the oxides of nitrogen, and the latter are subsequently determined by reduction to ammonia, distillation, and determination of the ammonia. Throughout the tests this method was employed. The procedure does not differ in essentials from that devised by Pearson, though there are several departures. The other method, by Francis & Parsons, uses phenol disulphonic acid. Mr. Wood states that limitation of time prevented working comparisons between the two methods, and it must not be concluded that he regards the reduction method as superior to the phenol disulphonic acid method; each may have its advantages in special cases.

The "Normen."

The report also contains information concerning recent work on carbon monoxide, the examination of the flames of gas appliances by a pyrographic method, and German standard specifications for the examination of gas rings and burners for domestic gas cookers. Regarding the latter, the requirements to be fulfilled as regards carbon monoxide production are as follows: "The CO content of the waste gases, based on the theoretical dry products of combustion should not exceed 0·10 p.ct. by volume, either at full consumption or when turned down, whether only one or all the burners are in operation. Gas rings which are not free from objection in this respect will not be approved." The German specifications (the "Normen") also cover: A full description of the appliance, especially of the burners; tests for gas-tightness of all parts carrying "live" gas; determination of the character of the flame, and its distribution with a pan in position; the gas consumption, and the behaviour of each burner when turned low, especially as regards back-firing, and the effect of using different proportions of coal gas and water gas is also ascertained; determination of the thermal efficiency by a water-boiling test under carefully standardized conditions; and a summary of the results of tests and the expression of an opinion upon the construction of the appliance and its general suitability for domestic use. It is understood that specifications and tests for other types of gas appliances are under consideration.

A Heavy but Necessary Dose.

The first speaker in the discussion was Prof. Smithells, who expressed sympathy with the Chairman's earlier comments on reports generally. "The detailed information in the 28th Report," he said, "is a really heavy dose even for a scientific person such as myself. To those whose business is not science, but is mainly practice, it must seem to be much more than is called for by the circumstances; but I do not think this is the case." Such an investigation as that dealt with in the report demands the utmost minuteness, but the outcome is essentially practical. The importance of determining minute quantities of carbon monoxide is great, and it is essential that the facts concerning gas combustion should be elicited. The Gas Industry undoubtedly adopted the right plan when it came to the conclusion that the facts ought to be determined, and stated fearlessly. In concluding, Prof. Smithells said: "We have to produce figures with reference to the production of carbon monoxide which will challenge the criticism of the whole world—the medical, hygienic, and many other interests which at once suggest themselves to our minds. By means of this research we can put plainly before the public the fact that the quantities of injurious substances present in the products of combustion of gas in ordinary circumstances cannot be regarded as of any serious consequence or of any danger. It is a very great thing to have done that; and I should like to offer my meed of praise for the admirable work Mr. Wood has done."

One Bird per Stone.

Mr. Masterman wondered why the reduction method in the determination of oxides of nitrogen was used by Mr. Wood when the phenol-disulphonic acid method is acknowledged as being more convenient. To this Mr. Wood replied that when he started the work there was a possibility with the reduction method of killing two birds with one stone—the possibility of being able not only to remove the oxides of nitrogen and prevent their interference with the determination of carbon monoxide, but afterwards to determine the quantity of oxides of nitrogen from the absorbent. This, however, turned out to be unfeasible. Mr. Masterman pointed out that in the report there is no indication of an attempt to determine the origin of the nitrogen peroxide, whether from the nitrogen in the air or from that in the gas itself. Also, it would be helpful if there was some indication whether any effective action could be taken to reduce the formation of oxides of nitrogen, and whether other sources of heat, such as electric radiators and oil lamps, produce nitrogen peroxide to the same degree. Mr. Wood thinks that the nitric oxide comes from the oxidation of the nitrogen of the atmosphere during combustion. As to the amounts of oxides of nitrogen produced by the combustion of candles and oil lamps, these are much of the same order as are obtained from gaseous combustion.

Killing the Bogey.

Details of experimental procedure were mentioned by Mr. A. R. Pearson, who is fully appreciative of the painstaking work which has gone to the making of the report. Mr. Clark, who remarked on the usefulness of such work as is done at Leeds to those who are carrying out investigations at Watson House, said that the work carried out at Leeds in the past few years has done a lot towards killing the bogey of carbon monoxide, and probably the work at Watson House would be the last nail in the bogey's coffin; and the nitric oxide bogey may be similarly despatched. Concerning oxides of nitrogen, Mr. Clark observed that in the past electric arc lamps were a competitive weapon against gas lighting, yet, although these lamps must have produced copious quantities of oxides of nitrogen, nothing was heard of it. Mr. Rhead queried how far nitric oxide affects the sulphur compounds to produce sulphur trioxide, so rendering the sulphur compounds more corrosive to the metalwork than they would be otherwise. In reply to this Mr. Wood said there is little doubt that the oxides of nitrogen do increase the corrosive action of sulphur acids in the gas. The last speaker in the discussion was Dr. J. S. Haldane, the eminent physiologist, who referred to an accident in connection with a gas engine exhaust. This accident, which occurred some years ago, was attributed to carbon monoxide, but he felt sure that carbon monoxide was not the cause of the trouble. The symptoms were similar to those of poisoning by oxides of nitrogen, and he thought it would be interesting for the Committee to investigate the matter.

The "Private" Report.

It was appropriate that the first item on the programme for Tuesday afternoon should be consideration of the "private" report, for the subject was also the combustion products of gas appliances. This report was presented by Mr. Masterman and Mr. Dunning, on behalf of the Watson House Research Laboratories of the Gas Light and Coke Company; and it is an important practical contribution to the science of gas utilization. It brings together in generalized form the results of combustion tests

on over 400 gas appliances of various types. There are four sections to the report. In the first section the physiological effect of the various gases constituting the products of combustion is discussed in relation to both the complete and the incomplete combustion of town gas. In no normal circumstances, it is emphasized, can unhealthy conditions arise from the normal products, but if carbon monoxide is produced as a result of abnormal conditions serious danger to health may follow. In the next section the theoretical considerations affecting combustion are discussed with special reference to the production of carbon monoxide, the only predisposing conditions being lack of access of air or a persistent flame chilling or a combination of the two.

The main body of the report in the third is concerned with analyzing the experimentally determined behaviour of various types of appliances in the light of the theoretical considerations governing combustion. The appliances are classified into three types—those having free burning flames, those having a restricted supply of air to the flame, and those in which the flames actually make contact with solid surfaces. It is pointed out that, if carbon monoxide is produced in appreciable quantities it is due to well-defined and avoidable causes perfectly consistent with theoretical considerations. In the absence of these causes the production of carbon monoxide is so low as to be negligible.

Causes and Remedies of Incomplete Combustion.

In the concluding section of this clearly-written and easily-understandable report, it is stated that, with modern gas appliances properly adjusted but without flues, the first physiologically appreciable effect in the absence of ventilation will be an increase in temperature and relative humidity. This will be succeeded by a perception of the presence of sulphur oxide. At a later stage this would become intolerable and ultimately dangerous, simultaneously with increase in respiratory rate due to the mounting carbon dioxide concentration. Not until this stage was far advanced would the carbon monoxide concentration approach the maximum safe limit of 0·02 p.ct., which limit is, in fact, above the concentration normally found in the undiluted flue products of gas appliances.

The carbon monoxide production from any appliance at normal gas rate is usually less than 0·2 c.ft. per therm, and a production exceeding 0·5 c.ft. per therm can always be attributed to some definite and avoidable cause. Increases well above this figure may follow lack of access of oxygen to the flame due to unsuitable air inlet or inadequate flueways, or to excessive gas rate. Under-aeration or inadequate flame space may seriously prejudice the combustion of flame contact appliances which are otherwise not less good than other types of appliances. Any cases of poisoning which have occurred from the products of combustion have undoubtedly been due to abnormal carbon monoxide production consequent upon one or several of these avoidable causes. In the absence of such defect in the appliance or installation, unsatisfactory combustion can only be due to excessive gas rate.

Finally the authors, interpreting the potential causes of unsatisfactory combustion into practical terms, observe that hygienic freedom from carbon monoxide can be ensured by attention to the following points: In regard to the appliance itself, the provision of adequate air entry, combustion space, and flueways, together with correct burner design, in relation to the desired gas rate. This rate must govern claims regarding heat input and efficiency. The workmanship employed and the materials used must be such as to maintain the critical dimensions of the original design during production and use. As to installation, this demands the correct assembly of the appliance, proper adjustment of gas rate and burner aeration, and correct flue equipment. In regard to operation, there must be control of local pressure variations, to avoid excessive gas rate or lighting-back; and adequate maintenance is necessary to remove deposits and repair mechanical damage. The report is the most helpful which we have yet encountered on the causes of incomplete combustion and the way in which it can be avoided.

Luminous and Aerated Burners.

That we are by no means alone in this idea was obvious from the discussion which followed the presentation of the report—a "private" report which deserves all the publicity and attention it can possibly get. The point was made by Mr. Firth, of Leeds, that the information given in the report could be usefully employed by every gas undertaking and appliance designer in the Kingdom. Among several queries which he put to the authors was whether the service capacity of a geyser could be increased by the use of aerated burners instead of luminous burners. This broad question has been fought out many times before, and Mr. Dunning in his reply said that on the whole the advantages are much more in favour of the luminous burner. This can be turned down to a much lower rate than the aerated burner, and it is much less complicated in design, and providing the flame space is sufficient with the luminous burner, then there is no advantage with the aerated burner. The only reason we need to use the aerated burner is where we definitely must have flame contact in the combustion space.

Heating and Ventilation.

Mr. Forshaw wonders whether the Industry in its outlook on gas-fire heating is not going too far in the direction of ventilation, and he suggests that gas fires could do with a lot less ventilating than they sometimes get. By providing a smaller flue, but one which would properly vent the products of combustion, the efficiency of the fire would be raised, and, therefore, the heating cost to the consumer proportionately lowered. With Mr. Forshaw's idea Prof. Cobb does not find himself in complete agreement; he regards the gas fire as being an example of an appliance which combines two functions in a most admirable way—the function of the heater and that of the ventilator. It seems to him that this is a position which the Gas Industry should be slow to sacrifice. In regard to the report in general, Prof. Cobb welcomes it as a new and very important type of contribution. "It would be a bad day for our Industry," he remarked, "if it adopted the view that the whole of this research work could be carried out by a small central staff of research workers. It is rather the idea that these central researches may be directed towards the solution of a few general and difficult problems of the Gas Industry, but if they are going to be worth anything they should provide the source of many other researches, which in many cases can be better carried out by the individual gas undertakings." Prof. Cobb's opinion of the gas fire is shared by Dr. Parker, who believes that it would be a retrograde step if the Gas Industry went in the direction of reducing ventilation in order to increase the efficiency of heating a room by probably only 2 or 3 p.ct.

Among other matters Mr. Wood referred to the novel method of stating carbon monoxide production which has been introduced in the report—namely, carbon monoxide production per therm. Though he regards this as convenient, and as being a method which will yield comparable results for any one undertaking, he feels strongly that it is not a fundamental relationship, and that it may give rise to irregularities in comparing gases of widely differing chemical composition.

Both Dr. Angus and Mr. A. T. Gilbert emphasized the important part which the fitter plays in the efficient functioning of gas appliances. The latter speaker, by the way, suggests that the Gas Industry ought to make some move "to regularize both appliances and their fitting." Mr. Clark pointed out how easy it is to avoid the evils of bad combustion if we properly apply chemistry and mechanical design together. "It has," he said, "been my business at different times to examine many appliances. Some of them have been masterpieces of workmanship, but they will not do what they were designed to do—burn gas. It is surprisingly easy to see how the proper application of chemistry will enable a design which will avoid many of the troubles that have given the Industry causes of complaint in the past."

An interesting question asked during the discussion was, what is a typical geyser? To this Mr. Dunning replied that it is impossible to define a typical geyser. Even with geysers of a particular type supposed to have been carefully made to dimensions, he has found large variations in the efficiency of combustion due to a very slight increase or decrease in a particular critical measurement.

In the course of his reply to the discussion, Mr. Master-

man emphasized that it is wrong to assume that the radiation obtained at present from a gas fire is the best that can be accomplished.

Ammonia Destruction and Utilization.

The afternoon session on Tuesday was brought to a close by consideration of the 1st Report of the Liquor Effluents and Ammonia Sub-Committee. As our readers are aware, Dr. Monkhouse, who has done such excellent research work for the Institution, is now an Alkali Inspector; and the report has been prepared by his successor as Research Chemist—Dr. A. Key. In regard to the constitution of the Sub-Committee, by the way, a gratifying feature is that the Chief Alkali Inspector, Mr. W. A. Damon, has accepted an invitation to become a member. It ought to be emphasized that a considerable portion of the Committee's work, undertaken mainly by Mr. Botley, with the assistance of the research chemists, consists of advice rendered and tests carried out in connection with the special problems of individual companies and authorities, and does not find its way into the report; nevertheless, the latter is full of interest, and many of the findings, it is easy to appreciate, are of immediate practical value.

Much has been heard lately, for instance, about getting rid of ammoniacal liquor and " devil " liquor by evaporation on the bars of gas producers; and Dr. Key gives the results of tests carried out on a Woodall-Duckham setting at Hinckley. An amount of spent liquor equivalent to 16 gallons per ton of coal carbonized can be disposed of when the water normally supplied to the producers is replaced by liquor. No objectionable products result with the exception of a small quantity of sulphur dioxide in the flue gases, and there has been no interference with the normal working. To dispose of a greater quantity of spent liquor than that which displaces the normal supply of water to the producers would be costly in fuel, besides creating other difficulties. Calculation has shown that the cost in fuel alone of destroying the whole of the spent liquor by this process varies from £1 9s. 3d. to £3 15s. 4d. per ton of sulphate of ammonia, depending on whether the liquor is from horizontal or vertical retorts, and on the presence or absence of waste heat boilers. The position is that a certain quantity of liquor can be disposed of in this way at a negligible cost, but that beyond this point the process is decidedly expensive. Ammonia liquor can also be evaporated on producer bars, though with greater difficulty, including that of increased corrosion. Such evaporation would be particularly applicable to the liquor first condensed.

In regard to the utilization of ammonia, the report points out the possibility of recovering ammonium chloride from circulating liquor. It is shown that by working-up the circulating liquor to a concentration of 12 to 20 p.ct. of chloride, and then evaporating, a salt can be obtained which contains a comparatively small amount of impurity and which can be easily purified. It is suggested, however, that a process for making ammonium bicarbonate would be more generally applicable. Pot experiments are now in hand on the virtues of bicarbonate as a fertilizer.

Solvents for Phenol.

Much work has been done to determine the relative value of various solvents for phenol and for higher tar acids, which latter have to be taken specially into account when any solvent extraction process is applied to gas-works, as distinct from coke-oven, liquors. Static experiments in the laboratory have been supplemented by others made on a small experimental plant which has been erected at Coventry, in which counter-current operation is possible. It has been shown that tricresyl phosphate and possibly tar oil have marked advantages over benzole for the extraction of the higher tar acids. It is estimated that the high cost of tricresyl phosphate would be balanced by its decreased solubility in water, the ease with which phenols can be recovered from it by simple distillation, and its high solvent power for phenols and higher tar acids.

Introducing the report, Mr. Botley, the Chairman of the Sub-Committee, emphasized the point that, though there are means of disposing of crude liquor which can be employed, any haphazard methods of disposal may have very unpleasant results and may cast discredit on those who are working at the problem. While the Committee strongly deprecates these haphazard methods, it offers assistance to all undertakings who desire to avail themselves of it.

A Matter of Dilution.

The discussion was opened by Mr. F. R. O'Shaughnessy, of the Tame and Rea Drainage Board, who congratulated the Sub-Committee on the excellent work which is being done for the Gas Industry. He is in general agreement with the view that the significance of trade wastes as affecting the problem of sewage disposal may be summed up in the word dilution. The percentage of gas liquor which may be tolerated in a sewage has had to be modified owing to changes in gas-works practice; and it is clear that relatively small variations in the percentage volume of gas liquor in the sewage cause trouble in the sewage purification plant. In spite of this, however, Mr. O'Shaughnessy thinks there is a tendency to minimize the problem represented by gas liquor in sewage, and he emphasized, in the interests of both the Gas Industry and sewage authorities, that such an attitude is to be deprecated. His experience leads him to insist that it is altogether unjustifiable to generalize about the amount of gas liquor which may be admitted to sewage; each case must be considered on its merits. In regard to the method employed for purification at Coventry, he suggests that the results show the limitations of this procedure. The method must be regarded as very expensive.

Dephenolating Plant at Partington.

Mr. Holton then gave the meeting some valuable information relating to the dephenolating plant at the Partington Works, which information will be found published separately in this issue of the " JOURNAL." He explained that consistent working has been one of the most noticeable features of the plant, which operates at high efficiency. Carbon filters are used for the extraction of benzole from the dephenolated liquor, and as a result the actual loss of benzole is exceedingly small. The report, as already noted, suggests that phenols could be easily recovered by distillation if tricresyl phosphate were used, but Mr. Holton suggested that such distillation would leave in the tricresyl phosphate the pitch, tarry matter, and so on, associated with the phenols in the liquor, and so gradually render the phosphate unfit for use.

It would be an advantage, thinks Dr. Monkhouse, if Mr. Holton would give the reasons for recovery by distillation of crude phenols from the benzole-phenol mixture, for in the majority of German plants soda washing is adopted. Concerning the disposal of liquors in producers, Dr. Monkhouse said that at Hinckley it was possible to work with a dry ash pan, though this could hardly be done generally. He pointed out that the putting of ammonia liquor containing ammonium chloride on producer bars must mean either the formation of hydrochloric acid or undecomposed ammonia chloride, and these might find their way into the waste gas flue. This factor would have to be considered in connection with waste-heat boilers.

The difference between the disposal of ammonia liquor and effluent liquor was emphasized by Dr. Parker. The disposal of crude liquor is a very difficult problem; and he warned his hearers that the real method is to try to cheapen the recovery of ammonia.

The Margate Cracking Method.

Mr. Prater, of Margate, showed how by a process patented by Mr. Campbell and himself his Company have been able not only to cut their losses on ammonia, but actually to make a slight profit. The idea is to crack the ammonia in vertical retorts. After considerable laboratory and experimental work in a single retort, the Company have been disposing of the whole of their free ammonia without the production of sulphate. The method described by Mr. Prater is certainly one of great interest.

Dr. Key wonders why Mr. Holton uses such a large proportion of benzole to liquor in his dephenolating plant. From the Sub-Committee's work it has been found that the efficiency of extraction is not greatly dependent upon the proportion of benzole, provided it exceeds a minimum. Mr. Holton uses 60 to 70 p.ct., whereas less than 45 p.ct. might prove adequate. If Mr. Holton employed this amount, said Dr. Key, his distillation costs would be greatly reduced. Another point mentioned by Dr. Key

was that crude benzole might prove as efficient as the more refined product which is being used by Mr. Holton; and this again would reduce costs.

Street Lighting.

At a time when the virtues of gas as an illuminant are being more and more recognized by lighting authorities and the general public, the 1st Report of the Street Lighting Committee, presentation and discussion of which commenced the proceedings at Wednesday morning's session, is singularly welcome. There is definitely a movement for better street lighting, necessitated by fast moving traffic of ever-increasing volume; and there has been ample evidence during the past twelve months that gas is particularly well fitted to satisfy modern lighting requirements. In this respect the admirable demonstrations of gas lighting in connection with the International Illumination Congress unquestionably did a power of good; but this very movement for better illumination and safer streets will, as the report points out, accentuate the increasingly severe competition among lighting interests. Our Industry, it is rightly remarked, cannot maintain its superiority in street lighting in the face of State-aided electrical competition, if efforts are not continually made to ensure and increase its efficiency. Numerical predominance is not sufficient. "Although good gas lighting may be observed in one district, it does not necessarily follow that this fact will influence the lighting authority in another town where similar illumination results are absent. It may occur in such case that any change will be to electricity, in consequence of the failure of the gas undertaking to keep its lighting up-to-date and/or by reason of the tendency of lighting authorities to follow the State in encouraging electricity. The merits of gas lighting for streets on the grounds of quality of illumination, diffusion of light, absence of glare, reliability, and economy can be easily rendered ineffective where street lamp installations are inefficient, or out of date."

Consequently the report urges the necessity for all gas engineers and other officials responsible for lighting to be conversant with the revised B.E.S.A. Specification; and the application of the Specification to the Gas Industry is dealt with. As is known, the A-H Classes of the Specification are based on foot-candle values achieved when the lighting installations are in every respect new; illumination under service conditions must not be less than one-half of the rated value. Herein lies one of the advantages of gas. With ordinary maintenance, the illumination under service conditions will not fall so low as only 50 p.ct. of the rated value.

Effecting Improvements.

Increase in candle power and closer spacing of the columns means expenditure. But where extensive immediate alteration is not possible, there is no doubt that gas undertakings could in many instances achieve improvements which, though costing them little, would raise the illumination values and, at the same time, draw attention to the merits of gas and help in its extended use for street illumination. Gas undertakings, it is suggested in the report, should fit up suitable lamps of modern type in one or more thoroughfares and direct the attention of the local lighting authorities to their possibilities. Laymen cannot be expected to keep themselves informed of gas lighting developments, and local demonstrations are necessary. It should be remembered that the comparison of existing gas lamps is usually with electricity used in up-to-date street installations; hence the advisability of displacing old-fashioned gas lanterns by modern ones and of providing the best type of burner equipment procurable. In this respect the report gives many practical hints. Particularly important is increase in mounting height of the light source; and it is pointed out that, where expense precludes the replacement of existing by taller lamp columns, the addition of an extension piece is not costly; special castings to suit the design of the column can be procured at low cost—and there are other alternatives.

Advantages of Gas.

Consideration is given to directional devices which are now available for gas street lighting, and examples are cited to illustrate the improved illumination which can be obtained. The advisability is mentioned of employing governors to minimize the effect of variation of pressure where the variation is abnormal, and the positive gain which follows the adoption of clock controllers comes in for comment. Then the advantages of gas are set out—absence of glare, greater penetration of fog and mist (which can easily be demonstrated where adjacent gas and electric light installations exist), reliability, and economy. The reliability of a gas lighted installation is well known, and this applies both to the gas supply and the lamp equipment. Where lamps are fitted with units made up of several mantles, the temporary failure of one mantle does not necessarily affect the others and light is still available. As to economy, the question of charges for public lamps is, of course, a matter for local decision. But it is obviously desirable that the gas consumed should be supplied on at least the lowest terms given to consumers, in view of the quantity involved and the fact that a considerable proportion is used after midnight when consumption is desired. There is in addition the advertisement afforded. The advantage which accrues from a low charge for gas is increased by the moderate cost of maintenance. The renewal of mantles is not expensive and by avoiding broken or frayed mantles the relative constancy of candle power is ensured. The latter is more important than low mantle average, and it is not always recognized that provided a mantle is unbroken its lighting power is practically unimpaired. The necessity for adequate maintenance generally cannot be too strongly emphasized.

An Example from Hull.

The Chairman of the Street Lighting Committee for 1931 was Mr. Harold Copp, by virtue of his office as President of the Institution of Gas Engineers, and before Mr. Watson rose to introduce the report Mr. Copp gave the members an idea of the reasons which made it desirable to constitute the Committee, one of the chief of which was to offer assistance to the smaller undertakings to retain the gas street lighting load in face of severe competition. Mr. Copp explained that the Committee affords an excellent example of the value of co-operation with manufacturers. He cited the efforts of his own concern—the British Gas Light Company—as an instance of what can be done in face of electrical competition. The Hull Corporation some time ago decided to convert the whole of the street lighting to electricity, but thanks to the work of Mr. Copp, with the assistance of the National Gas Council, the case as presented to the Ministry of Health resulted in their refusing the Corporation sanction to borrow the necessary amount required to meet the cost of conversion from gas lighting to electric lighting. As an outcome of this decision, the Gas Company have installed four examples of what they think public lighting by gas should be, and they claim that at the same expense the gas lighting has double the effective value of the electric lighting it was proposed to install. Great emphasis was laid by Mr. Copp on the necessity for charging the lowest possible price for gas used for public lighting.

The B.E.S.A. Specification.

Mr. Robert Watson, as Vice-Chairman of the Committee, then introduced the report in an exceedingly able manner. He said it was well realized by the Committee that in many cases the gas lighting of streets left nothing to be desired. The point is that this state of affairs is not general. Those who attended the International Illumination Congress were able to see many magnificent examples of gas lighting; but had they toured the country more thoroughly they would undoubtedly have come to the conclusion that efficient gas lighting is not general. Turning to the B.E.S.A. Specification for Street Lighting, Mr. Watson gave his views in support of the evaluation of street lighting on the basis of the minimum foot-candle value of the midway point between adjacent lamp columns. As for the Specification in general, compliance with its provisions has already produced improved results; this applies particularly to the increased mounting heights stipulated by the Specification. Mr. Watson also called attention to the great improvements and distribution of light which may be brought about by the use of directional devices, which prevent waste of useful flux

of light from ordinary gas burners. In this respect he gave some extraordinarily useful figures.

The Depreciation Factor.

A valuable contribution to the discussion was made by Mr. F. C. Smith, of the Gas Light and Coke Company. He referred, among other things, to the desirability of planning new installations on more scientific lines, and suggested that the public lighting engineer would be well advised to construct an isolux diagram for any proposed installation. Such a course was followed in connection with the new lighting of Whitehall, and results obtained by the planning and those which were obtained in actual use were practically identical, showing the accuracy of the method. Mr. Smith said how necessary it is for all connected with lighting to employ some form of portable photometer. He also referred to the depreciation factor of street lighting installations, demonstrating how greatly superior gas is to electricity in this respect. A fall of 5 p.ct. in the voltage is accompanied by a loss of luminous output from a tungsten lamp of approximately 18 p.ct., whereas an increase of 5 p.ct. in the supply voltage will increase the luminous output by some 19 p.ct. But the life of an incandescent lamp is greatly prejudiced if continually worked at an over-voltage. On the other hand, with a gas unit, a 5 p.ct. variation in the supply pressure will have but small effect upon the luminous output; moreover, pressure variations can be almost entirely eliminated by providing a governor. Experience over a number of years has shown that with high-pressure lamps under good maintenance a depreciation factor of from 25 to 30 p.ct. is an ample allowance. For low-pressure lamps a depreciation factor lower than 25 p.ct. can probably be secured. Hence the Gas Industry does not require a 50 p.ct. depreciation factor in a lighting specification—the factor at present allowed by the B.E.S.A. Specification.

The "Foreman Scavenger."

Capt. Liberty, who pointed to the general advance in public lighting practice during the last two or three years, amused the meeting by his remarks regarding lighting departments. Recently he sent out a questionnaire to many towns, and received replies signed officially by the town clerks. From these questionnaires he discovered that the titles of those who are in charge of the public lighting include, in a lengthy list, the following: Fire Master, Inspector of Cleansing, Inspector of Subways, Inspector of Overhead Wires; and, perhaps the most amusing, Foreman Scavenger.

Mr. Lofts followed, and said that the whole success or otherwise of the gas street lighting load depends upon the price at which gas can be supplied. He gave an example of electrical competition which certainly appears to favour electricity; we can only hope that his figures are by no means generally applicable. The subject of glare was dealt with by Mr. Minchin, of the Gas Light and Coke Company, to whose remarks Mr. Watson replied that gas lighting does not present any great difficulty in respect of glare. "By increasing the height of lamps, you can," he said, "eliminate the glare difficulty."

Liming of Coal.

This brought us to the Gas Fellowship Report. The subject of the research seems to us somewhat out of touch with current conditions in the Industry, but the results do clear up an important point in the lengthy investigation on the influence of inorganic constituents in the carbonization and gasification of coal.

In former work Gas Fellows have demonstrated that lime added to a strongly caking or medium caking coal increases materially the ammonia yield when the coal is heated in stages to 1000° C. in an atmosphere of nitrogen. There has, however, always been some doubt as to how far liming could be relied upon to give more ammonia with different coals and no satisfactory explanation has been forthcoming as to why lime should have this effect. Consequently experiments were made in which the lime, instead of being mixed with the coal prior to heating, was used in the form of a separate plug maintained at the same temperature as the coal, so that the lime could not influence the coal by direct contact with it (facilitating the expulsion of nitrogen as ammonia), but could exercise, if it were capable of doing so, its effect on the volatile matter expelled from the coal. This effect may be, and probably is, the summation of two opposed effects, the first being a dissociation of some of the ammonia present in the stream of volatile matter, into nitrogen and hydrogen, and the other a formation of ammonia by the decomposition of volatile nitrogen compounds present in the gas stream. The indication of the results obtained was clear. The amount of ammonia obtained when the lime was used as a plug was within experimental limits the same as when the lime was mixed with the coal. The influence of lime in increasing the ammonia yield was therefore clearly traced to its effect in decomposing volatile nitrogen compounds expelled from the coal, and not to an effect in actually expelling nitrogen from the coal in the form of ammonia.

Parallelism.

In his summary to the report, the Research Fellow, Dr. A. H. Eastwood, explains that a noticeable feature in tracing the ammonia production on heating bituminous coal in nitrogen is the marked maximum in ammonia evolution which occurs at 700° C. To trace a suspected parallelism in the evolution of gas and ammonia, samples were taken of gas and ammonia at different times during each hundred degrees stage of heating, so that, for example, it was known not only how much gas and ammonia had escaped during heating for an hour at 600° C., or 700° C., but at what rates the gas and ammonia had come off at different times during these one-hour periods. A close parallelism is obtained between the expulsion of ammonia and of carbonization gases (mainly hydrogen), which would suggest that the compounds decomposing in the coal with maximum rate of decomposition at 700° C. were yielding gas and ammonia at the same time; the two products coming from the same compounds, or compounds so similar that they decompose at the same time.

Dilution by Steaming.

The only person to join the discussion on this report was Dr. Pexton, but his contribution is one to which attention should certainly be paid. He pointed out that the yields of ammonia from some of the Gas Light and Coke Company's installations of large vertical retorts are low compared with those from their horizontal retorts and smaller vertical retorts. From this he draws the conclusion that in these particular retorts there is more degradation of ammonia, and consequently of hydrocarbons, taking place. In consequence, the calorific value of the coal gas, as distinct from the mixed gas, is much lower than in the smaller retort installations, and this restricts seriously the amount of water gas which can be added to reduce the calorific value of the mixed gas to the desired standard—*i.e.*, by addition of steaming. "It is sometimes imagined," said Dr. Pexton, "that a carbonizing plant which produces no ammonia would be a boon to the Gas Industry. I think, however, that if such a plant were invented, it would produce such low grade gas that it would be of interest only to very few undertakings."

The President's Visit to America.

Mr. Gibson, who again occupied the chair, in opening the meeting on Wednesday afternoon said: The President, as you know, has paid a visit to America, and he has prepared a short report which I will read to you:

In accordance with the unanimous desire of the Council, the President attended, as the representative of the Institution of Gas Engineers, the Annual Convention of the American Gas Association at Atlantic City from Oct. 12 to 16, 1931. On his way to the United States of America he visited the Canadian Gas Association at Toronto, and was cordially received by certain of the officers of the Association, including Mr. McNair, their President, who had travelled 1000 miles from Winnipeg to meet him.

Mr. Canning conveyed the heartiest greetings of the Institution of Gas Engineers to the Canadian Gas Association and to the American Gas Convention, and expressed, on your behalf, his best wishes for the continued prosperity of the Gas Industry in the United States and Canada. In this connection it is gratifying to have the President's report that—in spite of severe hydro-electric competition—gas continues to progress steadily.

Your President would like to express his sincere and deep ap-

preciation of the very great kindness and consideration extended to him by both Associations, and he feels confident that the visit has contributed towards cementing yet further the friendly relations which exist, and that we may expect an even greater measure of co-operation in the future.

I am sure, remarked Mr. Gibson, that we are very grateful to the President for representing us so ably in America; and we are very glad to have his report.

This brought us to the discussion on the use of creosote.

Creosote as an Enriching Agent.

The 29th Report of the Joint Research Committee on the use of creosote in the manufacture of carburetted water gas makes it plain that creosote is a long way from being a carburant *par excellence*. The last report on this subject, presented at the research meeting of the Institution in November, 1930, showed that the use of creosote in the carburettor of a water gas set, either alone or in admixture with gas oil, did not offer a promising method for its disposal; but the results obtained indicated that a greater thermal yield of gas might be given by the creosote if it were cracked at temperatures above 900° C. Dr. Dent, the Research Chemist, points out that such temperatures exist in the generator, and, if proved advantageous, the creosote could be passed with the steam through the fuel bed. This was the basis of the 1930-31 investigation, which was carried out on the laboratory scale. The temperature range studied extended up to 1300° C., using atmospheres of hydrogen and steam. However, the yield of gas obtained by cracking creosote in an atmosphere of hydrogen at such high temperatures is not greater than the yield at 900° C. Actually, when the temperature is above 1100° C., the yield is less.

The tars obtained from creosote, when it is cracked at temperatures below 900° C., are liquid, when the considerable quantities of naphthalene present have been filtered off. In the experiment at 1000° C., however, the tar was in the form of a very dense pitch, while above 1000° C. the material which was separated from the gas was of a sooty nature, no liquid tar being present. This sooty material was in a very bulky form, and its amount was equivalent to more than 70 p.ct. by weight of the oil used. It was anticipated that such material would give rise to difficulties if produced in the generator of a water gas plant. Consequently, it was interesting to ascertain whether the material could be gasified in an atmosphere containing steam, since such an atmosphere would exist in the fuel bed. The results obtained when creosote was decomposed in the presence of steam show that the sooty material is extremely unreactive, and, at temperatures as high as 1300° C., the amount produced is not appreciably reduced by the steam. It is believed that the soot is mainly the solid decomposition product of the aromatic compounds in the creosote.

Also, the injection of oil into the generator would absorb heat from the fuel bed and consequently would lead to an increase in the coke consumption, and, since the maximum thermal yield of gas obtained from creosote still represents less than half of the heat of combustion of the original oil, the results of the experiments indicate that cracking creosote, by passing it through the fuel bed, would only prove economical in exceptional circumstances.

Sidelights on Carburetting.

Information confirming the work of Mr. R. H. Griffith was given on the carburetting of gas oil. It was found that gas oil gives a maximum thermal yield of gas when decomposed at temperatures between 750° and 800° C.; the optimum temperature depends on the nature of the atmosphere and the rate of oil supply used. Below 750° C. a lower thermal yield of gas and a greater percentage of tar are obtained as a result of the decomposition of the oil being less complete, while hydrogenation of unsaturated hydrocarbons and, to a lesser extent, the splitting-up of gaseous hydrocarbons into carbon and hydrogen, appears to be responsible for the reduction in the potential heat in the gas when the temperature is above 800° C.

Three Methods of Marketing Creosote.

Valuable information on the results of tests carried out at Bromley with both heavy fuel oil and creosote in an automatically operated (Humphreys & Glasgow) set was given by Mr. Reidie. By the modifications made to the plant it was found possible to use both these carburetting agents successfully. The creosote yielded 0·75 therm per gallon, while the enriching value of the heavy fuel oil was only slightly lower than of gas oil. It is not, therefore, that creosote cannot be successfully employed as an enriching agent, but it is that such a course is not a commercial proposition with the prices of gas oils as they are to-day and as they are likely to remain.

Moreover, as Mr. Hollings pointed out, there are at least three alternative methods of marketing creosote. First, it can be used in Diesel engines—a potential market open to every tar distiller. Secondly, in the internal combustion engine of the spark ignition type, creosote possesses a very definite advantage over petroleum oil in its anti-knock properties. Thirdly, there are the possibilities of hydrogenation. "We have," said Mr. Hollings, "all heard a great deal during the past few months upon the subject of hydrogenating coal, and there has been such emphasis laid upon the coal that there is some danger that sight may be lost of the fact that tar oils are much easier to hydrogenate than coal. First of all there is the mechanical advantage of handling a liquid rather than a paste of coal and tar at the very high pressure involved. Then, considering that hydrogen is such an important factor in the cost of the process, it is important to bear in mind that tar oil such as creosote requires only one-half as much hydrogen as does coal. This is a subject which ought to receive most serious consideration by the Gas Industry. We possess the most suitable indigenous raw material which exists in quantity to-day. We also have the potential sources of hydrogen, and we can use the methane and other rich gases which are a bye-product from the process as a substitute for gas oil in the enrichment of water gas." The Gas Light and Coke Company has been investigating the hydrogenation of tar for some time, and has produced motor spirit from creosote.

Dr. King followed up Mr. Hollings' remarks by explaining the similarly good results which have been gained by hydrogenating creosote oil at the Fuel Research Board Station. He has operated a small continuous plant with an even more unpromising material than creosote oil—low-temperature tar. The plant is relatively simple, and the catalyst is the only problem which remains to be solved.

Refractory Materials.

The last of the technical fare was the 22nd Report of the Refractory Materials Joint Sub-Committee. The researches described in this report were carried out by Mr. A. T. Green in conjunction with several co-workers. One piece of work relates to the permeability of refractory materials to gases. While it is often asserted that the main leakage in gas retorts occurs at the joints, it is necessary to measure the permeability of the material of construction in order to vindicate this assertion. Also, in so far as the deterioration of a refractory product is due to penetration by corrosive vapours or even fine solid particles, the property of permeability will be a governing factor. The materials selected for the experiments included representative samples of the better known silica and fireclay products of this country, together with a sample of diatomite insulating material. The investigation revealed that there is no definite relationship between the percentage porosity and the permeability coefficients. In general the porosity of a straight silica product is greater than that of an average fireclay product, and the permeability of the silica brick is, on the average, greater than that of a firebrick. The insulating material, with a porosity of 70 p.ct., however, gave, with one exception, the lowest permeability of the whole series.

A method is described by which the permeability to nitrogen of five fireclay, five silica, and one siliceous, materials has been directly measured at temperatures up to 500° C. As the temperature increases the permeability is found to decrease, in a manner almost independent of the nature of the material and the value of its permeability coefficient at ordinary temperatures. For a temperature increase from 10° to 500°, the permeability is reduced to almost half its value for fireclay products, and to slightly less than this value for silica materials. The increase in the viscosity of the gas with rise in temperature is shown to account almost quantitatively for the decrease in per-

meability, but, in addition, small variations in the results for the different products suggest the dependence to a minor degree on a further factor related to the pore structure of the material. The inversions between 100° and 250° C. in the low specific gravity forms of silica are suggested as the explanation of the divergence of the results between the fireclay and silica products.

The results of water penetration and water permeability tests are such that when the products are placed in order of increasing penetrability, they are also arranged in order of increasing permeability to water. This order is very nearly the same as that of increasing permeability to air. The water penetration test, it thus appears, may be used as a quick, qualitative comparison of permeability for the types of materials used in the experiments.

Another research was concerned with the disintegration of fireclay products by carbon monoxide. There appears to be some correlation between the type of "iron spot" and the tendency of the brick to disintegrate under the action of carbon monoxide; but there is no apparent relationship between the "iron" content of the brick, as determined by chemical analysis, and the tendency to disintegrate. An analysis of the factors governing disintegration suggest that the most important may be (1) the character of the ferruginous matter; (2) the permeability of the brick; and (3) the strength and elasticity of the matrix of the brick, together with the extent of the adhesion of the grog in the mass—*i.e.*, the "internal strength" of the material. The experiments point to the fact that the character of the ferruginous matter masks the influences of the other factors.

Hot-Patching of Retorts.

The report points out that work on hot-patching cements has now been in progress for some time. A good number of possible mixtures has been evolved and tested in the laboratory. The difficulties are obviously connected with the ingredients, which must give "stickability" over a wide range of temperature, without the possibility of injury to the retort. Arrangements have been made to carry out tests with probable hot-patching cements on different types of retort settings in different parts of the country (London, Birmingham, and Liverpool). The work has now reached the stage when a start can be made with these plant investigations.

There are at least two aspects of hot-patching to receive consideration. In the first place, a method of hot-patching is used to fill up small holes in the retort structure, probably at the joints, which result in gas leakage. The cement gun is used for this purpose, and appears to give good results, particularly, if it is used after every scurfing. This seems to be the significance of the term "hot-patching" in certain sections of the Industry. To some gas engineers, however, it would appear that the methods of hot-patching must be capable of a far more extensive application, in fact, to large areas of the retort, which (say) have shown pronounced flaking. This, of course, is a very difficult proposition. It is obvious, therefore, that these two aspects of hot-patching must be clearly differentiated.

Jointing Materials.

In the useful discussion which followed Mr. Green's clear and brief outline of the report, Mr. Frank West expressed his belief that the results, from the financial point of view, of the work which has been carried out by the Research Association give back their value at least £ for £ in regard to what has been expended in the past.

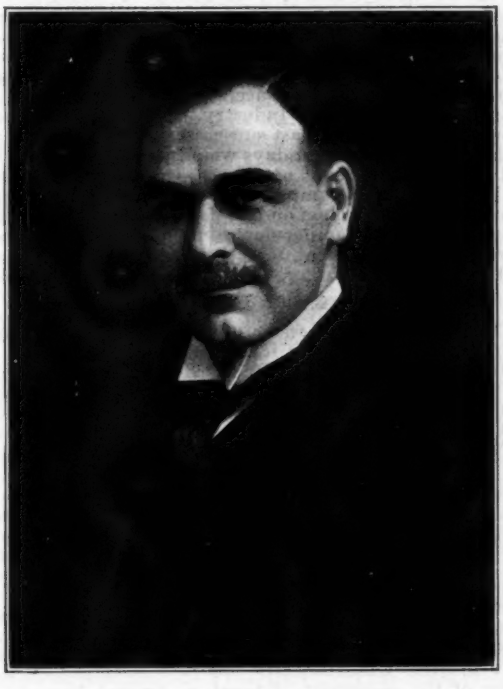
The remarks of Mr. Edwards, of the Beckton Station of the Gas Light and Coke Company, who spoke solely on the question of jointing material, will be read with the greatest interest. He put forward an important account of the uses of pure quartz with a small amount of alumina and some sort of material to give it plasticity as being a solution of the problem as far as a jointing material for horizontal retorts is concerned. But Mr. Rhead, of Birmingham, questioned whether such material would be suitable, owing to its high expansion, for application to vertical retorts.

On the question of permeability, Mr. Rhead said that this is not a serious cause of thermal loss in vertical retorts; what little loss there is is far overshadowed by that through parting joints and general leakage. The loss by permeability is rendered still less by the deposition of scurf in the upper portions of the retort, and in the water gas zone of the ferruginous slag. In regard to hot patching, he suggests that the method of application needs a lot of consideration, and he does not feel that it is good practice to apply wet materials to a red hot retort. In this connection experiments have been carried out at Birmingham. The idea has been to pass a dry powder or dry graded material down a tube, and then let that be met at the point of application in the retort by a stream of compressed air or air of coal gas—later he is going to try to use oxygen—and put a little carbonaceous material into the jointing material to produce combustion and heat up the joint as the material passes into it.

In the course of his reply Mr. Green said that in his opinion what is wanted is a different type of jointing cement for the different zones of a vertical retort. We must develop different cements for the different zones where we know the actions are essentially different.

Closing Stages.

Mr. Gibson, before explaining that it had been decided that in the future the Annual Meetings of the Institution would commence on the first Tuesday in June, and the Research Meetings on the first Tuesday in November, reported the result of the ballot for the election of Members, Associate Members, and Associates of the Institution.



Mr. RALPH E. GIBSON, of Liverpool,

Senior Vice-President of the Institution, who occupied the Chair in the absence of the President, Mr. J. H. Canning.

The final item on the programme was an omnibus vote of thanks, proposed by Mr. Belton, of Shrewsbury, to all who had contributed to the success of the meeting; and special reference was made to the excellent work of the Institution's Secretary, Mr. Alexander, and to the admirable manner in which Mr. Gibson had throughout occupied the chair.

Luncheon to the Research Workers

The Third Autumn Research Meeting Luncheon was held at the Savoy Hotel, London, on Tuesday, Nov. 3—Mr. R. E. Gibson presiding in the absence of the President. There was a large attendance of members and guests, among them were Sir Joseph Petavel, F.R.S. (Director, National Physical Laboratory); Mr. A. Abbott (Chief Inspector, Board of Education); Capt. J. M. Donaldson (President, Institution of Electrical Engineers); Mr. E. Kitson Clark (President, Institution of Mechanical Engineers); Sir David Milne-Watson, Sir Francis Goodenough, Mrs. M. A. Cloudesley Brereton, and Dr. Margaret Fishenden.

After the toast of "The King,"

The CHAIRMAN, proposing "Our Guests," explained the absence of the President through sudden illness, and said that these Research Luncheons are given to express the thanks of the members of the Institution to those responsible for, or interested in, the research and education work which the Institution carries out on behalf of the Gas Industry.

PROPHECY.

Sir JOSEPH PETAVEL, who responded first to the toast, said he wished to talk about economics and relativity. [Laughter and Oh!]. In the case of a subject so profound as the one he proposed to deal with, it was essential to get definitions correct. An economic expert was one who, after long study and the experience of a lifetime, was able to forecast, after the event, the principal changes which were likely to occur in our financial and industrial system. The economist had the privilege of forecasting, post event, the principal things that were likely to occur; and he proposed to adopt that system. Assuming they were at present in the year 1863, he was prepared to forecast the fate and the progress of the Gas Industry. [Loud laughter.] There was a prosperous Industry and a newly founded Institution of Gas Engineers, and he forecast for them both a continued progress and success. Later on the Institution would obtain a Charter, and then, being discontented with a Charter from the Board of Trade, it would insist on having a Royal Charter. He forecast that the Institution would convoke the first International Congress of gas engineers, that it would found a research branch, and that it would endow researches. He could see that these researches would be highly successful.

Speaking of the Gas Industry, as apart from the Institution, he could forecast surprising advances. The semi-twilight of the Victorian days would be replaced by a burst of brilliance that could not have been anticipated, and he could foresee, as a climax, the humble pedestrian walking along Whitehall at close on midnight in the warm and beneficent sunlight streaming down in a glow of magnificence. [Loud laughter.] That was the brilliant career he forecast for the Gas Industry.

A FARTHING IN THE POUND.

The gift of prophecy was a useful thing, and he therefore proposed to go one step further. According to the principles of relativity the advance of time was of no importance, and therefore he proposed to go back for 30 years, and having congratulated the Industry on the success it had achieved, he would ask them to imagine what would have been the position to-day if the Industry had put aside say ¼d. in the £ for research, instead of what had been done. The sum of ¼d. in the £ was relatively a small sum, but if that had been done, the Gas Industry, instead of keeping level with its opponents and the rest of the world, would have been vastly ahead of them—say, by perhaps ten years—and in that event the millions sterling that would have come in would have been vastly out of proportion to the amount that had been spent. That was the question he wished to bring forward, and he could only hope that something would come of the suggestion in the near future. Unfortunately, his powers of prophecy, like those of the economist, did not go beyond Nov. 3, 1931, but there were present business men of great ability who might, when they went home, give a little thought to that matter and arrange for that contribution of ¼d. about which he had been speaking.

MORE AND BETTER RESEARCH.

Mr. A. ABBOTT, who also responded to the toast, said it was to be gathered that the object of the eloquent speech just delivered by Sir Joseph Petavel was to extract a certain amount of money for research work—a most praiseworthy object. This gathering was concerned with both research and education, and it seemed to him appropriate that they should be discussed together. Indeed, the whole object of the Institution Research meeting was to discuss both. During the past fifteen years there had been an immense development in connection with research. The State had spent a large sum of money on research and had encouraged it to a greater extent than ever before. There was the National Physical Laboratory and the great Departments dealing with fuel, food, timber, and building. There were also the Research Associations, and the research work carried out by such bodies as the Institution. Therefore, on the whole, the body of research being carried out in this country at the present time was far greater than it had ever been before. Some of the results obtained were of immediate practical value, and some were not; and the question he wished to ask was whether it was considered that the progress of education was keeping pace with that of research. Personally, he was not at all sure it was. If he might prophesy also, it seemed to him that in the long run the gas engineer and the general manager of any great undertaking must act as liaison officer—and a competent liaison officer—between the research organization and the works. He must be able to understand, without the thing being written down for his approbation, exactly what the research people were doing, and he must also be able to look round his undertaking and say whether the results should be adopted and fitted to his own job without delay.

DEVELOPMENT OF EDUCATION.

Side by side with this development in industry there had been development of an important nature in regard to education. The whole educational system of the country had been re-modelled in the last thirty years. The progress of educational organization in this country had been faster in the last thirty years than in any country in the world. The Institution had every reason to be satisfied with the work done by the Education Committee under very considerable difficulties. These difficulties would not have been surmounted but for the very keen interest shown by the Industry, and especially by the Chairmen of the Committee. In this connection he wished specially to mention the name of Mr. John Terrace. There were representatives on the Committee from England, Scotland, and Ireland, and also Wales; but the Committee had worked in a most harmonious manner, although it was not generally recognized what difficulties it had had to face. A great deal of credit was due to the District Committees and for their very cordial co-operation.

Capt. J. M. DONALDSON, proposing "The Institution of Gas Engineers," said it might appear extraordinary to an outsider that the President of the Institution of Electrical Engineers—and a supply man at that—should be called upon to propose this toast. But the two industries—gas and electricity—helped each other along, and they adopted the very good commercial maxim that anybody who could sell their products only by shouting down the other people's was not in the first rank. That was very proper.

Mr. HAROLD E. COPP, responding to the toast, first extended a very hearty welcome to Sir Francis Goodenough on his return from America. Sir Francis, he said, had only just arrived in England and he had conceived it to be his first duty to attend this luncheon, another instance of his continued sympathy with the educational objects of the Institution. Personally he could see nothing incongruous in the fact that the President of the Institution of Electrical Engineers should be present and propose this toast. Presumably the centre of the planetary system, with its numerous institutions, would be regarded as the Institution of Civil Engineers; but he submitted that both the Institution of Gas Engineers and the Institution of Electrical Engineers were bright stars in the same constellation. He had the honour of knowing several of the Presidents of the Institution of Electrical Engineers, and whenever he talked with them he appreciated that they possessed a profound knowledge of the relative positions of the electrical engineer and the gas engineer. Some people thought there were too many institutions, and there certainly was a very large number. But of all institutions it could be claimed that the Institution of Gas Engineers justified its existence largely because it was primarily an educational institution, and its accomplishments in that direction had been most marked. It had established the relationships between the young aspirant to the profession of gas engineer and the actual facts of the Industry. There were good grounds for being gratified at the very distinguished gathering at this luncheon. They had met primarily to do honour to those who were conducting the research work of the Institution; and he ventured to suggest that, whatever might happen to the electricity industry—and he wished it all success—or whatever might happen to the Gas Industry, in the future there was a great field for what he would call the carbonizing industries.

Education in the Industry

Report of the Gas Education Committee for 1930-31

The CHAIRMAN (Mr. Ralph E. Gibson): In the absence of the President and Sir Francis Goodenough, I beg to submit the Report of the Gas Education Committee for 1930-31 and should like to draw your attention to one or two items in it. In the first place the Report covers a period of about 13½ months and includes the examination results of 1930 and 1931. That is due to the fact that formerly the Education Committee Report has been presented at the June Meetings of the Institution, but the Council has decided, and I think rightly, to present it in future at the Autumn Meeting. The Education Scheme administration has been reorganized during the year, and we believe that the steps which have been taken will conduce to efficiency and greater effectiveness generally. Attention is drawn in the Report to the fact that the examinations held under the Education Scheme provide a recognized means of entry to the various classes of membership of the Institution, and the co-operation of gas engineers is invited in drawing the attention of their young men to this fact. A great deal depends upon the District Education Committees in connection with this Scheme, and our thanks are due to those Committees, their Chairmen and Secretaries, whose names are given in the Report, for the valuable work they do. We are glad to notice that the number of candidates for the Minor Course Examinations is increasing; I think that is a good sign. Then we are told that teachers' courses in gas engineering and gas supply, organized by Mr. C. H. Creasey, have been held both in 1930 and 1931. They have been well attended, and I am quite sure they must have been very helpful to the teachers who have been engaged in this work.

Mr. T. H. PRATER, of Margate (South-Eastern District Committee): I think the Education Committee has placed before the Institution a very satisfactory Report, and to my mind the most satisfactory features are the large increase in the attendance at classes on gas fitting and the large increase in the number of centres at which approved tuition can be obtained. Our gasfitters are the people in direct contact with the consumers; and in these days of competition it is nice to feel that the men who are interviewing our consumers are men who really understand the work upon which they are engaged. Not only are they efficient fitters, but, what is perhaps more important, they understand the fundamentals and the technical aspects of their work, and I feel that these courses enable them to explain technical matters in non-technical language to our consumers. Probably that is the most important aspect of this Report.

Mr. J. G. CLARK (Gas Light and Coke Company): It is particularly regrettable that Mr. Stephen Lacey is not able to be present; I know that he would have had something to say on this matter of the Education Scheme for, naturally, he takes an enormous interest not only from the point of view of technical education generally, but also from the point of view that a very large number of the men engaged in the Gas Sales Department of the Gas Light and Coke Company, of which Department he is controller, are working in the Scheme, and he feels a great interest in the welfare of those men.

ENTHUSIASM OF THE STUDENTS.

Speaking for myself, in the first place I think it is well for the Institution to know what a lot of work the students themselves are putting into the Scheme. It is my privilege and pleasure on behalf of Mr. Lacey to visit the technical institutes within the area of the Gas Light and Coke Company once or twice during each session, and I am always impressed by the intense enthusiasm with which the men set about their work. These men work hard during the day, and the enthusiasm with which they tackle the jobs at the evening classes afterwards is a matter upon which the Institution ought to be congratulated. It shows at any rate that the students are doing their bit, and this should encourage the Institution to ensure that no stone is left unturned to make the way as easy as possible for those students. Only a few days ago I attended a newly formed class at Southend, and I found there no fewer than between 50 and 60 men working hard, trying their best to master the work and so to fit themselves better for their employment. In many cases these men are working under difficulties, because the technical institutes are not always equipped as adequately as one would like them to be; it is very common in London, at any rate, to find inadequate accommodation for the students, and often they have to do their work in circumstances which one cannot regard as the best. Nevertheless, they are working hard and enthusiastically, as though their lives depended upon it. That says a good deal for the instructors also; instructors who can create in their students the enthusiasm which is very common among these students are certainly to be congratulated. As to the examinations themselves, in London it is necessary for the Gas Light and Coke Company to lend premises for the holding of the City and Guilds Gas Fitting Examination; the candidates have to sit for the examination on Saturday afternoons, generally in early May, and nine times out of ten the weather is very hot, but the men work hard at their examinations, and they inspire anyone with the feeling that they are at any rate doing their utmost to get on with their jobs.

DESIRABILITY OF MODELS.

With regard to gas supply, I am not quite so happy. It has been my privilege to be associated with Mr. Lacey in the setting and the reading of the examination papers, and it seems that there is still something more to be done in regard to gas supply. I should like to suggest to the Gas Education Committee that something should be done to provide the instructors with suggestions or ideas and perhaps equipment whereby the phenomena of gas supply could be demonstrated by means of models. I think that Mr. Creasey, of the Board of Education, would not mind my saying that in connection with the Teachers' Training Course in Birmingham this year he was responsible for several very clever and simple models for demonstrating the principles underlying the work. We have to remember that the gas supply man is in a position rather different from that of the gas-works man. He has not the opportunities of becoming acquainted with the technique of using scientific instruments. I know that in some gas supply classes there are some very excellent laboratories where men can make experiments and obtain a good first-hand acquaintance with some of the things which otherwise they could only know from reading or from lectures. But that does not go far enough, I think. The opportunities afforded the gas supply man to acquire skill to manipulate scientific instruments are very few, and I sometimes doubt whether the students at the classes obtain the utmost benefit.

The teaching should be supplemented by demonstrations, by means of simple models which the instructors themselves can operate. The instructors are men who have already acquired skill in manipulating instruments, and their skill can be imparted to the students. Unless the students are given the opportunities at these courses to acquire skill in manipulating instruments it may take them a long time to become proficient in practice; and meantime the results they will obtain will be disappointing. It is no easy matter to design models to illustrate the principles; indeed, it will be far more difficult to do that than to run an ordinary laboratory. I hope the day may come when we shall have in the Gas Industry somebody with the genius of, say, Sylvanus P. Thompson, who did wonderful work for the electrical industry in this very direction, using very cleverly designed models to show vividly some of the things which are not easily grasped by a man who is not used to scientific investigation. Prof. Perry did the same thing for mechanical engineers. I believe it is on record that even Lord Kelvin, one of the greatest scientific men we ever had, confessed at one time that he would never pretend to understand a scientific theory until he had made a model to demonstrate it. If that applied to Lord Kelvin, how much more does it apply to lesser individuals such as ourselves? One solution of the problem may be arrived at by inviting those who are regularly engaged in this sort of work to make suggestions as to models which would serve that purpose. We at Watson House are frequently bothered to design models to illustrate these things for our staff and I have no doubt that similar ideas can be obtained from other places which are well to the fore in this matter of technical education. I should like to emphasize that point for the consideration of the Gas Education Committee. I do not think it is really reasonable to expect the gas supply student to acquire the full technique of operating scientific

instruments as it is acquired by a man working in the laboratory.

DIPLOMA IN GAS SUPPLY.

With regard to the Diploma, there are some who regard it as deplorable that even after quite a considerable number of years—I think the Scheme has been working for eight or nine years—we have not yet a Diploma student in gas supply. There are a good many explanations of this fact. Of course, there are quite a number of students on the gas engineering side who have Diplomas, and you may ask why there are no Diploma students on the gas supply side, but I am not going into the pros and cons of that now. You will all recognize that the two branches of the work are in many respects totally different. The man in the works has innumerable opportunities of obtaining data, even though he may not be engaged in a very leading capacity; he can walk round the condensers, for example, take out thermometers and determine temperatures, and so on, and can find out a lot for himself quite easily. But the gas supply man goes out to get business, and the people he meets are not the people who want investigations. They want gas fires, gas cookers, gas water heaters, and so on, but not explanations. That is the fundamental difference between the two branches of work. Anyhow, I understand from a discussion I heard in Birmingham that between now and the next examination the Institution is to consider suggestions as to means of guiding gas supply students to obtain Diplomas. I do not feel very sanguine about it myself, but whatever is done will have to be done, I think, on lines entirely different from those to which we are accustomed in connection with gas engineering.

I am not speaking on behalf of Mr. Lacey this morning. I do not know whether he would subscribe to what I have said, but I feel impelled to make these remarks, as the result of my experience in London.

The CHAIRMAN: We are very much obliged to Mr. Clark for his remarks. Those of us who have visited Watson House must have been filled with admiration with the work that is being carried on there under the guidance of Mr. Clark. We believe the young men who receive training there will receive a thorough groundwork of knowledge of their subjects and will be very useful men in the Industry later on. I was much interested in Mr. Clark's remarks concerning gas supply. There appears to be a disinclination, not only in London but throughout the country, to take up gas supply; and I think this is a matter which the Education Committee should consider, and it should endeavour to make the subject more popular; it is a very important subject and one which needs special attention.

General Research Committee

Second Report, 1930-31

The CHAIRMAN (Mr. Ralph E. Gibson): This Report, giving a general survey of the work done during the year, does not lend itself very much to discussion, as there will be opportunities for discussing each Report separately later. We have with us, however, Mr. Harold Copp, who was Chairman of the Committee for the year 1930-31, and I shall be glad if he will present it.

Mr. HAROLD COPP (Past-President): One gratifying feature is the indication that pipe researches are now admitted; I think you will all agree that that is a step in the right direction. During the year three new Committees have been formed, one on meters, another on street lighting, and another on tar, all of which are subjects which require investigation. The Meters Committee has met two or three times and has certainly done some valuable work. The Street Lighting Committee's Report will be presented to you to-morrow, and I will say nothing about that at the moment. The Tar Committee has not yet met, but I feel certain there is a field for research on the composition and application of tar.

Last year the General Research Committee visited the special exhibition of appliances at Watson House. That visit was very much appreciated, and I should like to say how very deeply grateful we are to the Gas Light and Coke Company and to Mr. Clark for the very valuable information and for the excellent exhibition of appliances which they provided for us.

A very satisfactory feature of the 28th Report of the Joint Research Committee of the Institution and Leeds University is that it contains a communication from the South Metropolitan Gas Company, and I should like to say how much we all welcome such a contribution. The 29th Report deals with the use of creosote in water gas plants, but unfortunately the results of that investigation were rather negative. A number of us tried to use creosote unsuccessfully; hence that investigation. We can say, however, that the investigation has cleared the atmosphere; we know now what we cannot do.

OFFICIAL INSPECTION OF GASHOLDERS.

We had another Sub-Committee dealing with gasholders. The object of its formation was to avoid, if possible, the necessity for Government or official inspection of our gasholders. I really do think that gas engineers are quite a capable body of men, capable of examining the exterior of their gasholders to make sure that they are in proper working condition. The only thing they cannot do is to inspect the interior, and I submit that no Government inspector, however brilliant, can do that, without emptying the tank; anyone can do it when the tank is empty and clear. So that I do not think the Sub-Committee can go very much further.

The Liquor Effluents and Ammonia Sub-Committee has undoubtedly done very valuable work. I need only mention two places—namely, Hinckley and Coventry—where, for all practical purposes, they have solved the very real difficulties which existed, and I think Mr. Botley, the Chairman of that Committee, is to be congratulated.

With regard to the work of the Purifiers Sub-Committee, that is another case where very little can be done. Gas engineers are so careful a body of men that they have not provided anything to investigate, or, at any rate, the cases that do occur are so rare that there is very little to investigate.

The Street Lighting Committee has met on two or three occasions, and I believe their work is covered practically by the British Engineering Standards Association.

Another Research Report which is very welcome is that from the Gas Light and Coke Company, which proves the truth of the results of the investigation which has been conducted at Leeds University—*i.e.*, that the dangers of CO are practically negligible and that such remote danger as may exist as the result of the combustion of gas in gas appliances is detected by reason of the presence with it of SO_2. The SO_2, therefore, serves as a danger signal.

The 22nd Report of the Refractory Materials Joint Sub-Committee also gives very valuable information, particularly on the question of the hot patching of retorts. We all know that the hot patching of retorts, particularly vertical retorts, is a matter of very great importance.

I may be accused of being avaricious or perhaps a little sordid, or even of being almost a Philistine, and I hope our friends at Leeds will not take offence at anything I may say, but I do really hope that in future the results of the investigations and researches which are being conducted, at very much cost to this Institution, may be translated into definite pecuniary advantage to the Gas Industry.

Mr. THOMAS HARDIE (Past-President, and Vice-Chairman of the General Research Committee): The great variety of subjects dealt with in this Report of the General Research Committee indicates that the Council of the Institution desires that all matters of importance to its members should be investigated. I think we can agree that the establishment of Standing Committees as has been done from time to time does result in the thorough investigation of these matters which require attention. That, followed by the introduction of this Autumn Meeting, which has greatly enhanced the value of the Reports of the Committees, has certainly helped forward the research work of the Institution. The Autumn Meeting itself has resulted in considerable advantage to the Institution, in that it has served to bring forward prominently to the notice of all interested the extensive and valuable work which the Institution does on behalf of the industry.

I think that Mr. Copp used quite a wrong expression when he said that the investigation dealt with in the 29th Report of the Joint Research Committee was negative in its results. I think the 29th Report is definitely very positive, for it tells us exactly what we can hope to get when working with creosote in carburetted water gas plants.

I am rather more hopeful of the results arising from the work of the Sub-Committees on gasholders and purifiers than Mr. Copp appears to be. I think there is quite a lot

for the Gasholders Sub-Committee still to do in preparing schemes for the proper inspection of gasholders and the recording of the inspections. Again, I think that the Purifiers Sub-Committee might very well prepare a list of precautions which should be taken in the emptying and filling of purifiers and in the erection and design of purifiers.

As Chairman of the Joint Research Committee of the Institution and Leeds University, I should like to say that we are sorry not to have ready for submission to you the Report on the comparative working of carburetted water gas plants with back-run, and without back-run. Dr. Dent and his staff have been busy on that work for the past few months, and although the experimental work itself is now completed they have still a considerable amount to do in connection with the analyses and calculations. For the purpose of the investigations modifications had to be made in the plant, and that occupied a considerable amount of time. The Report will prove to be very interesting, but I am afraid it must be held over until our next meeting.

Individual Research Work.

The decision to accept papers describing research work by undertakings themselves has brought forth for this meeting a very valuable contribution from Mr. C. A. Masterman. The research work by individual undertakings generally deals with current problems before those undertakings, and I am sure that if we have the results brought before us at our meetings they will add very much of interest. Not only will the information given prove advantageous to the members attending the meetings, but I think also that the opportunity given to private research workers to bring their work to the notice of others will prove very advantageous to themselves also.

Reference has been made by Mr. Copp to the value of the work of the Joint Research Committee, and I should like to say that we have had very many valuable suggestions from Mr. Copp as to the work which might be undertaken by the Committee and we are extremely thankful to him.

I hope the members here will take full advantage of this meeting to discuss fully all the Reports, which are of great variety. I am sure the Committees themselves will be very pleased indeed to have, and will give careful consideration to, any suggestions which will help them in solving the problems entrusted to them by the Council.

Lieut.-Col. W. M. Carr (Stretford): I want to take this opportunity of referring to the work done by one or two of the Research Committees whose Reports will not be discussed at this meeting. Mr. Hardie has referred to the Gasholders Sub-Committee, and has said, very rightly, that there remains a very great deal of important work for that Committee to do. He has also said, quite rightly, that probably its first and greatest work should be the preparation of a scheme of inspection, which is undoubtedly overdue. I do feel we ought not to lose sight of the fact that we as gas engineers are responsible for the inspection of our own holders, and we must be capable of carrying out that inspection in the most efficient manner. Suggestions for the inspection of gasholders have been made quite recently by insurance companies. Be that as it may, I suggest that it does not relieve the gas engineer of the primary responsibility for the maintenance of his plant. I feel that the schedule which was sent out to many gas undertakings under the name of an insurance company would have been better had it first received the seal of investigation and approval by the Gasholders Research Sub-Committee. It ought to be understood by gas engineers generally that that matter is being dealt with or will be dealt with by the Research Committee, and I hope that in due course we shall have a scheme on which to work, approved by that Committee. It will then be for those who may think it desirable as a secondary precaution only to consider the question of insurance.

I should also like to refer to the possibilities arising from the establishment of another new Sub-Committee—namely, the Tar Sub-Committee—and I hope that the research work that that Committee may be able to inaugurate will be helpful not only to this Institution but eventually to the users of tar, and particularly the users of tar on the roads. I feel that close working between the Institution and the British Road Tar Association is essential, and that our Institution, at any rate so far as we tar producers and distillers are concerned, is the proper body to conduct the primary and essential research, both in the production and the distillation of tar.

Industrial Gas Research.

In mentioning research in co-operation with other bodies, I do express the hope that research will develop on such lines that we shall come into close co-operation with users of gas, and I should like to suggest to the General Research Committee that they might consider the establishment of an Industrial Gas Research Sub-Committee. Many of us, particularly those who are supplying gas in industrial areas, feel the necessity for such a Committee. There is a great deal of work to be done, particularly in connection with furnace atmospheres, and the conductivity and melting of metals, and close co-operation between an Industrial Research Committee of this Institution and the representatives of the Leeds University, and those concerned with the metallurgical research which is being carried out at that same University and at Sheffield, will undoubtedly produce great results in a field to which we are looking for great advance—*i.e.*, the industrial heating field.

One can mention many problems which require research at the present moment, but I would like to mention particularly the use of creosote in internal combustion engines. The consideration of that matter may be considered a function of the General Research Committee, or a matter to be referred to the Tar Research Sub-Committee, but I do feel that this use of creosote is rapidly developing and that we ought to be early in the field with our investigations and research.

In conclusion, I should like to express my appreciation of the work that has been done by the various Research Committees during the past year.

Dr. E. W. Smith, C.B.E.: I strongly support Col. Carr's advocacy of the appointment of a Sub-Committee for the development of research work and the collection of information on industrial gas. We know that this subject of development of the sales of industrial gas is receiving a great deal of attention in different parts of the country. Industrial gas is being used very largely in Birmingham, and Watson House is assisting very greatly; I think that as an Institution we ought to keep a very close watch on these matters and help to direct the technical work on industrial gas. I also welcome the formation of a Tar Committee. No subject is of more importance to the Gas Industry to-day than the direct development of new outlets for tar. That leads me to remark on what has been said by Mr. Copp concerning the better utilization of research and a better perspective on the part of Leeds University in regard to the application of research to the problems of the Industry. I feel that whatever grouses we may have against Leeds University—and there are not many—and whatever criticisms we may have as to the amount of money that has been spent and the return that has been received, the solution of these things is in our own hands. We as an Institution, through our Committees, approve of the problems which should be tackled. We have been known even to initiate problems. We also have to approve of the personnel appointed, and we have to approve of the methods to be applied in tackling the problems that have been decided upon. From time to time we are in a position to decide—I do not say we do decide, but we are in a position to do so—whether sufficient time has been spent on a particular problem, whether the money spent on that particular problem was adequate or not, and we have every liberty to control our own destinies on this matter. We have Committees and Sub-Committees to deal with each of the subjects enumerated in our Reports. Thus, the Sub-Committees should not be, and are not, cyphers; they are the consultants to the chemists, and when the chemists bring forward reports at the request of those Committees in the manner in which the Committees want the Reports prepared, surely we cannot expect these more or less academic and highly trained men to know sufficient of the Industry and its problems to be able to interpret those results themselves, without assistance, in the manner that the Industry desires. If there is any defect in the method of application of the results that are obtained, that defect lies with us as members of the Committees, in my view, and if a change must be made—and I think it must, for I agree with Mr. Copp that a great deal more use can be made of the work of the Research Committees—it can only be brought about by the Committees helping the chemists a great deal more than they do. I hold very strongly that our Committees can assist the chemists a great deal more than they do by closer co-operation and by taking more responsibility for the nature and the interpretation of the work.

Work of the Research Committees.

Mr. Thomas Hardie (Chairman of the Joint Research Committee): Both Mr. Copp and Dr. Smith are members of the General Research Committee, and this Committee has control of the whole of the work of the Joint Research Committee. The programme of the work to be done is reported to the General Committee, and it has the power to say "No; do something else." We have endeavoured to get on to our Committees men who are most capable of suggesting what work should be carried out by the Joint Research Committee. It is quite unfair to saddle Leeds University or Prof. Cobb with the responsibility for selecting the work that has to be done or is about to be done. They are certainly very much responsible for directing the

work, and the help they give in making suggestions and in regard to the methods of carrying out that work are invaluable, but it is in the hands of the members of this Institution, by their appointments to the Committee, absolutely to control the work; that has been so from the very beginning, and it is so to-day. I have been a member of the Committee for some little time, and I have inquired from my colleagues around the table whether the work of the Research Committees was unsatisfactory, and if so how it was to be improved, but the suggestions that I have received have been few and far between, and as a rule they have been suggestions that it was impossible to carry out. With regard to the value of the work of the Research Committee from its inception some twenty years ago, if there is any member here who can say that it has not been of monetary value, then I shall be surprised. I myself have found it extremely valuable, and I can put into terms of £ s. d., the advantages which have been obtained from the many Reports of that Committee.

Mr. COPP: I am very glad to hear what Mr. Hardie has said. What I said at the end of my previous remarks was said more out of greed than anything else. I have attended a good many meetings both of the General Research Committee and the Joint Research Committee, and I have in my very humble way made suggestions from time to time, but I will say here and now that I yield to no one in my admiration of the thorough manner in which their work is done.

The CHAIRMAN: I agree thoroughly with the remarks Mr. Copp has just made as to the value of this research work. There can be no doubt that it is of tremendous value to the Industry. This Report now before us is the Second Report of the General Research Committee. It has not been customary in the past to issue a General Report, but I think it is very useful to have such a comprehensive Report because it sums up the situation and draws attention to the salient features of the research work that has been carried on. The General Research Committee is performing a very necessary function in supervising and co-ordinating the research work of the Institution, and no doubt the work will advance and improve as time goes on. We all welcome constructive criticism. Much valuable work has been done during the past year, and I think the research chemists and others who have taken part in it are to be congratulated on the results. I should like to utter a word of commendation of the excellent summaries of the Reports that have been published. My first impression, when reading the Reports themselves, was that they were far too long and contained far too much minute detail. The summaries are very helpful to those of us who in these very strenuous days find it difficult to allot the necessary time for the digestion of a number of long and highly technical communications. In my view, for the purpose of discussion and for practical use, it is unnecessary to give all the minute details of the chemical and physical researches that are carried out. Many of you will probably disagree with me in this, but I should like to see the Reports written as concisely as possible, with a clear and definite statement of the advances made and of the knowledge gained. The details are valuable for reference and perhaps are indispensable to a complete knowledge of the subject, but I do not think they are essential for the purposes of discussion at a general meeting of gas engineers. The Institution is a body composed mainly of practical engineers who have to apply the knowledge gained and to find out how much can be put to profitable use. While I appreciate that the work of our research chemists is invaluable and worthy of all praise, I do point out that research work is a means to an end, and its ultimate object must not be lost sight of. The practical application of the knowledge is really the most important matter to the Industry generally.

I am sure we are particularly glad to see for the first time a contribution from a private research laboratory, and I think that that practice should be encouraged wherever good research has been carried on which will add to the common stock of useful knowledge. I think we have been particularly fortunate this year in having had contributions which will prove very useful. Further, we must not forget the work that is being done by the various Committees which have not presented Reports now, and no doubt we shall have the benefit of their deliberations on some future occasion.

Mr. E. E. CALVERT (Stratford, London): There is a point I should like to raise concerning the work of the Meters Sub-Committee, and that is the question of determining the temperature of the gas in meters. I have known temperatures to be taken in three places—the gas on the inlet of the meter, the gas at the outlet of the meter, and the water in the meter. All these temperatures vary according to seasons, and according to whether the meter is inside or outside a building, and we want to be able to correct to some definite standard. With regard to the work of the Purifiers Sub-Committee, I do feel that the air admitted to purifiers should be controlled. I believe there are still works at which it is not metered; if it is not metered there is a tendency for the men working the plant to admit air in order to keep themselves out of trouble, but they are likely, in so doing, to do harm unknowingly. I think that may be the source of some recent accidents, and I suggest that the air admitted should be either metered or controlled by analysis.

The CHAIRMAN: The Meters Sub-Committee was appointed to deal with certain proposals for the periodical vertification of gas meters. No doubt the Committee, however, will bear in mind the remarks of Mr. Calvert, and there is no reason why it should not consider such other matters.

PART PLAYED BY LEEDS UNIVERSITY.

Prof. COBB: In the course of the discussion on this subject it appeared to me that it might be necessary to provide a reply of some length and in some detail, particularly as regards the remarks made concerning the excellencies and the deficiencies of the part played by the University of Leeds in these investigations. Much to my relief, I found that such a reply was entirely unnecessary, after the remarks of Mr. Hardie (Chairman of the Joint Research Committee), which remarks seem to me to put the whole matter in its place in an admirable way. There may be some misunderstanding, however, as to the way in which these researches are arranged and as to the part played by the University of Leeds, and it is advisable to be perfectly clear about these matters. There is a General Research Committee, the membership of which is drawn almost entirely from the Institution, although it has some members from outside. It is that Committee which decides the subjects for research to be undertaken on behalf of the Institution, and with Institution funds. If the research is such that the Institution is prepared to welcome the co-operation of the University of Leeds on equal terms, then the Joint Research Committee of the Institution and the University, the membership of which Committee is drawn partly from the Institution and partly from the University, takes up those subjects. Its efficiency of working is ensured by the Chairmanship of Mr. Hardie and the collaboration of carefully chosen members. Speaking with a long experience of the Committee, I do not think there would be any question at all—certainly no question would be raised by anybody who had ever worked on that Committee—of its usefulness in planning and in directing the research work of the University members. I think it only fair to them that I should make that comment, and I am pleased that in effect Mr. Hardie made it in advance. At the meetings of that Committee it is always made perfectly clear how willing the Committee is to accept and work upon suggestions from the members who come from the Industry as to what that work should be and how it should be done. Mr. Hardie has rather hinted, and I think it may be more than hinted, that if the Committee as such has a complaint, it is that the suggestions made to it from the Gas Industry are not in number or in practicability what the Committee itself would like to have, and for that reason I welcome the remarks that have been made by Dr. Smith and by Mr. Hardie, urging upon the members of the Gas Industry and members of these Committees the desirability of taking a more active share in the direction of the research work which we undertake.

With regard to the form of the Research Reports, in the first place to each Report there is a general introduction, which is brief and summary, and so far as it is possible for me to do so, it is written in non-technical terms, and gives a brief account of what we have been doing and of the results obtained. In addition to that brief summary, each Report has a more extended summary. The wording of that more extended summary is brought before the Joint Research Committee for careful consideration, it is then brought before the General Research Committee for careful consideration as to whether it is a satisfactory account of the research work carried on, expressed in terms suitable for a Report to the members of the Institution of Gas Engineers. How it would be practicable to secure a better summary than that I must say it is rather difficult to conceive. We assume that that second summary printed in each Report is what will be generally available to the members of the Institution. Then comes the Report *in extenso*. It is said that that Report goes into detail. It is intended to go into detail; it is intended to be a more or less exhaustive account of the research work carried on, giving so much detail that it is useful not only to a member reading the Report in a general way in order to see what the main points of it are, and to know in what research work the Institution is engaged, but also to people who wish to go into the matter in detail—people who are carrying out similar researches or are proposing to carry out research work of a similar character and who may be helped by a knowledge of the experience of the investigators working on behalf of the Institution. Let us

take just two particular examples. Can anybody connected with the Gas Industry or any other industry have a better preparation for any work that he is proposing to carry out himself on the products of combustion from gas appliances than to read the carefully detailed account given by Mr. Wood of the difficulties he has met and the manner in which he has surmounted them? Coming to the other side of the work, can any young chemist or technical manager who is proposing to investigate on his own account questions concerning the chemical or thermal balance of a water gas plant or a plant of a similar kind—and we hope there may be many such men—read anything better in preparation for it than the Report that has been drawn up by Dr. Dent and his collaborators on the work committed to their charge? But, of course, it has to be clearly understood that that detailed and extended account of the research work is not for the general consumption of members unless they happen to be specially interested in this particular research work and wish to know exactly what was done and to form their own opinions as to the methods used and the validity of the conclusions, and who may be looking for help in connection with the research work on which they are proposing to engage. That, then, is the plan on which these Reports are prepared, and it does seem to me to be necessary that that explanation should be forthcoming.

It is said that sometimes the wording is not as comprehensive as it might be, but I have already dealt with that by implication in the course of my remarks. The complexity increases as we go forward from the general introduction to the summary and from the summary to the detailed account.

Oxides of Nitrogen in Products of Gaseous Combustion

28th Report of the Joint Research Committee

Research Chemist: J. W. Wood, M.Sc., A.I.C.

Prof. Arthur Smithells, F.R.S.: Some remarks which have been made by the Chairman this morning have led me to speak in this discussion. I listened with very great sympathy to the Chairman's comments on the reports, especially in regard to the great difficulty which some of our reports present by reason of their wealth of detail. I do not think that that can be better exemplified anywhere than in the 28th Report of the Joint Research Committee. The detailed information in that Report is a really heavy dose even for a scientific person such as myself. To those whose business is not science, but is mainly practice, it must seem to be much more than is called for by the circumstances; but I do not believe that that is the case. I think this Report is an excellent example of the kind of investigation contingent upon practical affairs where the utmost minuteness is necessary, and where the work appears to be leading by very circuitous paths to presumably practical results. I must confess that I know something about the subject of the determination of minute quantities of CO. Of its importance I think there can be no question; everyone here must have heard from the earliest times the complaint about imperfect combustion of gas and contamination of the air by a particularly deadly substance known as CO. We know what a large number of head-lines have appeared in the newspapers with regard to it, the exaggeration, which has been found profitable to other people, in calling attention to the disadvantages of gas as compared with other sources of light, heat, and power; and it has been a matter of the utmost consequence that the facts should be elicited. There has been at times a doubt as to whether this matter should be stirred up at all, but I am delighted that the Industry has come to the conclusion that the facts ought to be determined and ought to be stated fearlessly. That is the motive behind this investigation.

Conduct of the Investigation.

With regard to the actual conduct of the investigation, I believe I am as much responsible as anybody for having called attention to the possibilities of determining minute quantities of CO with accuracy. This question arose from the fact that many years ago a French scientist decided to determine the proportion of this substance in the air in various quarters of the globe, in order to find out how far it had become a normal constituent of the air. It was this French chemist who worked out the iodine pentoxide process for determining minute quantities of CO. He made determinations in Paris, then in a forest, then near a lighthouse, and in many other places, but, although he took infinite pains to make the determinations with the greatest degree of accuracy then obtainable, his results were in fact so inaccurate that they are of no statistical value at all. That state of affairs arose, of course, from the incomplete investigation of the means of estimation which were required for such a delicate operation. The principles were sound, the method utilized was correct, and the investigator, I do not doubt, was most patient and honest. But this is a matter in which it is the last fraction that counts and where the most scrupulous attention must be given to detail.

No doubt nearly all of us here know something of the work that has been done since; I am happy to think that the work has been carried out in several quarters, and I am particularly glad to know that we are to have a contribution by Mr. C. A. Masterman, indicating the work he has done in the laboratories of the Gas Light and Coke Company in this connection. The determination of the quantities of chemical materials to the degree of accuracy which is now possible, and which, I believe, has been attained in Mr. Wood's work is, I can assure you, a very serious undertaking. It is wearisome and dreary, from the outsider's point of view, to have to work for so long in what may seem such a niggling way with little things; from the point of view of the insider, it is only the sense of having a great issue in his hands that enables a man such as Mr. Wood to go through the routine day after day and to devote the careful attention to detail which is necessary to produce results of the character now before us. There is perhaps an element of preaching in what I have said, but this is an example of the extreme kind of research in which the Gas Industry must engage. Reference to things such as devil liquors, back-run processes, and so on, which I do not understand, may seem to the practical man to represent more practical politics. Although I do not understand them, I do not entertain the least doubt as to the importance of researches on those matters, and I do beg that those engaged on the practical side may trust us who are serving on the Committees not to be wasting time in doing things which are not of importance. From the very start we have had the happiest co-operation in these Committees; I agree that sometimes our friends of the industry have not given us all the co-operation and all the personal encouragement we should have liked, but, of course, to be quite frank, in a matter such as the one we are now discussing we have not much to look for in that direction.

Sympathetic Encouragement.

We do not want much more than to allow Mr. Wood to have his chance of carrying out the work in the best way and with sympathetic encouragement such as is given by Mr. Shapley. I repeat that the work is of the first importance. We have to produce figures with reference to the production of CO which will challenge the criticism of the whole world—the medical, hygienic, and many other interests which at once suggest themselves to our minds. By means of this research we can put plainly before the public the fact that the quantities of injurious substances present in the products of combustion of gas in ordinary circumstances cannot be regarded as of any serious consequence or of any danger. It is a very great thing to have done that, and I should like to offer my meed of praise for the admirable work Mr. Wood has done.

Importance of the Work.

Mr. C. A. Masterman (Gas Light and Coke Company): The presence of oxides of nitrogen in the products of combustion from gas appliances has long been common knowledge. The present Report represents interesting confirmation of earlier experimental results to which attention is drawn in the Appendix. The very full information which is given as regards experimental technique will be of great value to other workers in this field, but the Report does not make clear why the reduction method was actually used when the phenol-disulphonic acid method is acknowledged as being apparently more convenient.

The close agreement between the results of this present Report and the results obtained in 1914 are remarkable, and can perhaps only be fully appreciated by those who have actually carried out the laborious work connected

with accurate determination of such small quantities of gases.

The importance of the presence of nitrogen peroxide in flue gases is two-fold. This gas, as stated in the Report, is likely to lead to more rapid corrosion, and if present in sufficient quantity may have ill-effects upon health if the flue gases pass into the room. The concentrations which are shown in this Report to be present in the normal products of combustion are unlikely to lead to serious ill-effects upon health, owing to the dilute condition in which the flue gases are normally present, but in the concentration in which they exist in the undiluted flue gases the nitrogen peroxide is certainly capable of mischief. Comparing the figures for toxicity of sulphur dioxide and nitrogen peroxide in what are stated to be the normal concentrations, the two gases will have an approximately equal effect from the point of view of initial irritation and subsequent toxicity. Danger to health from either is to a large degree guarded against by the fact that irritation is severe before serious effects can result.

What Can Be Done About It?

The present Report does not make clear whether there are circumstances in which the concentration of nitrogen peroxide is likely to mount considerably, as may happen with carbon monoxide. This seems unlikely, but there is no indication of an attempt to determine the origin of the nitrogen peroxide, whether from the nitrogen in the air or from nitrogen contained in the initial gas itself. This is a matter of great importance, since, if the latter is the case, we may anticipate at some future date the possibility of reducing the resultant nitrogen peroxide, as we may also hope to anticipate a reduction in the resultant sulphur dioxide. While it is interesting to note that the oxides of nitrogen are produced from gas appliances, it would be more helpful if we had some indication whether any effective action can be taken about it. At the same time, it would certainly be interesting to know whether other sources of heat, such as electric radiators, oil lamps and motor exhausts, produce nitrogen peroxide to the same degree. This would to some extent be related to the origin of the gas.

In congratulating the authors of this present Report upon the painstaking work which it undoubtedly represents, I must also offer my personal thanks to the President of the Council of the Institution for allowing me to be present as a guest to take part in this discussion.

The Question of Corrosion.

Mr. A. R. Pearson (South Metropolitan Gas Company): Mr. Wood and Mr. Davey have been so thorough in their experimental methods that they have carried the matter a good deal further than we were able to do in the time at our disposal. Such preliminary results as we obtained are, as a matter of fact, in accord with the results which they give in the Report; nevertheless, I am very pleased to hear that they propose to carry the matter further, using an independent method of investigation, because I feel that this is a matter of very great importance to the Industry, although it may seem, as some people have remarked, a little too scientific and technical. Its importance from the point of view of hygiene and of reassuring the consumers has already been mentioned, and I think it may turn out that the oxides of nitrogen play a more important part in the phenomenon of corrosion than perhaps we have appreciated hitherto. At any rate, the figures in the Report giving the amounts of oxides of nitrogen appearing in the condensate are very suggestive in that respect.

Coming to the experimental details, the sources of error have been so carefully examined that one has considerable diffidence in offering any criticism, but I should like to make one suggestion concerning the final reduction and distillation of the ammonia. It is possible that the process might be accelerated by using Devarda's alloy in place of zinc for the reduction. This alloy has the advantage that it is brittle and can be broken up into a coarse powder, so that it offers a bigger surface for the reduction. One other small criticism I should like to make with regard to the experimental methods concerns the use of rubber bungs for the final distillation. I rather suspect that sometimes the rubber in contact with steam, and still more in contact with alkaline spray, may produce minute traces of ammonia, and possibly this has something to do with the tailing-off of the ammonia distillate to which attention is drawn in the Report.

Beyond these remarks I have only to express my appreciation of the painstaking experimental work which has gone to the making of the Report.

Value of Leeds Researches.

Mr. J. G. Clark (Gas Light and Coke Company): I do feel that in the absence of Mr. Stephen Lacey I ought to say something on the general subject. We are very grateful to Leeds for this Report, which contains an enormous amount of information. In our work at Watson House we have naturally to cover a wider field, but we have to be constantly on the look-out for pointers to show us the way round the dark corners; these pointers we invariably find in the Reports from Leeds, and we are not disappointed on this occasion. They can come only as the result of very long and tedious detailed work; and we at Watson House appreciate it very much. It occurred to us that this carbon monoxide bogey which troubled us a good many years ago is gradually dying; the great work carried out at Leeds in the past few years has done a lot towards killing it, and the Report which is to be presented on the work at Watson House (concerning the combustion standards of gas appliances) may be the last nail in the coffin of the CO bogey, which has often been thrown up at the Gas Industry by people who are not very friendly towards us. It is not unlikely that we may kill this nitric oxide bogey too. I do not think the Press have heard much about nitric oxide yet; if they were to get hold of that and expand on it, and so give the public the view that we were hurling into the atmosphere huge quantities of nitric oxide, I think they would make things unpleasant for us again, though that would be a complete exaggeration of the whole situation. It is interesting to remember that, although we do not see arc lamps very much now, they were a great weapon in the hands of the electrical industry a few years ago, but they must have produced copious quantities of oxide of nitrogen. Although the arc lamp has gone out of use almost entirely, that fact is not due to its production of nitric oxide.

With regard to the figures in Appendix 3 showing the proportion of oxides of nitrogen normally present in the atmosphere, I should like to know whether the atmosphere referred to is that of London or any particular town, or the atmosphere in the country.

"A Small Sulphuric Acid Works."

Mr. T. F. E. Rhead (Birmingham): I should like to congratulate the Committee upon this very great piece of detailed work and upon their appreciation of the importance of fundamentals. A thought which has occurred to me is that in this process we have all the elements of a small sulphuric acid works—the steam, sulphur dioxide, and nitric oxide—and I wonder how far the nitric oxide affects the sulphur compounds to produce sulphur trioxide, so rendering those sulphur compounds more corrosive to the metalwork than they would be otherwise.

Dr. A. Key (Leeds University): As an instance of the value of detail in a Report, I should like to say that the details given in Appendix 3 will be of use to the Liquor Effluents and Ammonia Committee, or at any rate to their research staff, in the determination of nitrates in sewage effluents. That is an example of the value of detail in what is surely a most unexpected direction.

Mr. Wood's Reply.

Mr. Wood, replying to the discussion, said: I should like to acknowledge the encouragement which Prof. Smithells has given to the research staff; his words, coming from a man who has been associated with research work for the greater part of his life and has had personal experience of such work, are a real encouragement.

The question has been asked by Mr. Masterman as to why we used the reduction method when apparently the phenol-disulphonic acid method appeared to be more satisfactory. Before we started the work the details of the phenol-disulphonic acid method were placed in our hands. As I pointed out in the Report, there was a possibility of killing two birds with one stone, a possibility that we should be able not only to remove the oxides of nitrogen and thus prevent their interference with our carbon monoxide determinations by the chromic-sulphuric acid mixture, but afterwards should be able to determine the oxides of nitrogen in the chromic-sulphuric acid absorbent. It turns out in practice, however, that really to hold back hydrocarbons and oxides of nitrogen it is necessary still to separate the two tests and carry out the oxides of nitrogen determinations with very much smaller quantities of reagent than are used for merely holding them back. In one case it is a question of using a large quantity of reagent for qualitative holding back. In the other case it is a quantitative determination, and a very large quantity of sulphuric acid would militate against any reasonably accurate determination.

The other very important point raised is that of the origin of the nitric oxide. Personally I think it comes from oxidation of the nitrogen of the atmosphere during combustion. The only other suggestion was one made to me when I was in Berlin—that some of it might be due to the oxidation of small traces of ammonia left in the finished

gases or possibly small traces of cyanide compounds. But, as a matter of fact, we still get these oxides of nitrogen when perfectly pure hydrogen is burned and when perfectly pure methane is burned—either methane prepared in the laboratory or methane in the form of natural gas such as is available in fair quantities in some districts in America. As we get the nitric oxide in both these gases I do not attach any great weight to the alternative suggestion that it comes from ammonia. Also, in abstracting Terres' paper and publishing some of the matter in Appendix 5, I confined myself to gas appliances; the original paper contained references to the amount of oxides of nitrogen which are produced by the combustion of candles, and by oil lamps, and they are very much of the same order as are obtained from gaseous combustion, and I think there is little doubt that nitric oxide is also produced from motor car exhausts.

The figures in Appendix 5, showing the proportion of oxides of nitrogen normally present in the atmosphere are figures determined with air in the immediate vicinity of the Government laboratory in London. From the original figures it is quite evident that during fogs, or when there may be motor traffic of any considerable volume in the immediate vicinity, the quantity of oxides of nitrogen in the atmosphere may be increased as much as ten-fold. The use of arc lamps, of course, is a recognized method of producing the oxides of nitrogen for the production of synthetic nitric acid, air being drawn over the arc and the oxidation of the nitrogen taking place there.

The matter raised by Mr. Rhead is mentioned in the Report. There is little doubt that the oxides of nitrogen do increase the corrosive action of the sulphur acids in the gas: and when one examines the condensate (say) from a calorimeter, one will find that, whereas the bulk of the acid is present in the form of sulphuric acid, there is a certain amount still present as sulphurous acid.

With regard to Mr. Pearson's questions concerning the technique and the actual carrying out of the tests, we should very much have liked to have used Devarda's alloy, but we were working on the particulars which he had kindly furnished, and we wished to depart as little as possible from the conditions which he himself apparently had found to be fairly satisfactory, and we wished to standardize the surface of zinc used as much as possible. As to the use of rubber bungs, whenever we insert a new one we have trouble for several days—*i.e.*, until the bung has become seasoned—but after that time there is very little difficulty resulting from the evolution of ammonia, as is demonstrated by the fact that we can obtain very satisfactory blanks, even in the same apparatus, if the distillation is carried out in reasonable time. The alternative is the use of ground-glass joints; they are very nice, but expensive, and there is trouble due to joints sticking. Any practical chemist knows that ground-glass joints are not interchangeable, and if there is a breakage in any part of the ground-glass apparatus it means replacing the whole lot.

A Suggested Investigation.

Dr. J. S. Haldane, F.R.S. (the eminent physiologist, who was invited by the Chairman to contribute to the discussion), said: I was particularly interested in this Report because I have had a great deal to do with cases of poisoning. Nearly all these accidents have occurred in connection with the burning or the incomplete detonation of high explosives; a great many of them occurred during the war, and, of course, they are very serious and very dangerous accidents. But I am very glad to note, from the 28th Report of your Joint Research Committee, that the proportions of the oxides of nitrogen present in the products of the combustion of gas in ordinary appliances are, from the health point of view, absolutely inappreciable. But there is one kind of combustion of gas about which I am not so sure, and that is its combustion in gas engines. I do not know whether your Committee has made experiments on the products of combustion of gas in gas engines, which products of combustion, I take it, contain free oxygen particularly. I remember an accident which I suspected was due to that; it was attributed to CO, but I was perfectly certain that CO was not the cause of the trouble. The symptoms were similar to those of poisoning by oxides of nitrogen. I may be wrong in my conclusions, but it would be interesting if the Committee could investigate that matter.

The Chairman: We are very much obliged to Dr. Haldane for his contribution to the discussion, and no doubt the Committee will bear in mind the point he has raised in connection with gas engines.

Combustion Standards of Gas Appliances

Report Submitted by Mr. C. A. MASTERMAN, M.A., F.I.C., and Mr. E. W. B. DUNNING, B.Sc., A.I.C., on behalf of the Watson House Laboratories

Mr. F. Firth (Leeds): This work is a statement of facts based upon careful experiment, and the information given can be usefully employed by every gas undertaking and appliance designer in the Kingdom. The conditions which are the fundamental cause of incomplete combustion have been established as lack of excess air, flame chilling, or a combination of both; and all are avoidable. It is very interesting to be assured that except under abnormal conditions the discomforts from the products of combustion from a gas appliance in an ill-ventilated room are far greater than the risks from carbon monoxide poisoning, and this should be an effective counter to meet the irresponsible statements sometimes made of the dangers of flueless heaters, &c. The authors' outline of the reactions occurring in the course of combustion is most instructive, and from their explanations I suggest it is the proportion of hydrogen in the residual combustibles near the end of combustion which is responsible—due to the rate of flame velocity—for the completeness of combustion. From this it is possible that gas possesses an advantage over many other fuels, in which case it might be put to useful account in increasing the possible heat input to an appliance, by substituting gas for other fuels; in effect, increasing the potential capacity of the appliance. This, if confirmed in practice, would be a useful selling point. What are the authors' opinions on these points?

Geyser Burners.

Another point which might be raised is whether the service capacity of a geyser could be increased by using aerated burners instead of luminous burners. It is accepted that in this particular appliance the advantage of using luminous flames is very great, but conditions could exist where output swamped every other consideration; and on these grounds the opinion of the authors would be valuable. There is also the difference of behaviour of an aerated flame chilled under a pan or wash boiler and when chilled on the radiants of a gas fire. The chilling medium of the one is metal, and the other a poor conductor. Nevertheless, the CO formed is greater in the gas fire for equal variations in gas consumption than under the pan. Lack of secondary aeration would appear to be the reason; and I would like to ask whether the direction of travel of the combustible products, vertical or horizontal, has any influence.

A point which is probably outside this Report, but is closely connected with the combustion of gas, is whether the coal gas burned in a superheated incandescent burner loses its hydrogen by combustion in the superheater before reaching the burner nozzle; also whether the amount of water vapour in the combustion gases at a specific temperature is favourable to a higher hydrogen content in the residual gases which are finally burned on the fabric of the mantle. What part does this proportion of hydrogen play in the ultimate candle power of the mantle?

Finally, I would like to testify to the great value of this work to the Gas Industry; and we are again indebted to the Gas Light and Coke Company for their generosity in publishing the results of this valuable research work carried out at their own expense and given to the whole Industry.

Mr. F. C. Smith: I should like to ask the authors if they are convinced that, in a room where the ventilation conditions are such that the CO_2 may amount to a figure of 1 p.ct., this would be likely to affect the combustion of the gas in an appliance which would otherwise be quite satisfactory.

Mr. A. Forshaw (R. & A. Main, Ltd.): I am afraid I have not very much to say on this Report, because it has been put forward in such a form that it is very nearly impossible to criticize it; but I should like to pay my tribute to the excellence of it. Mr. Masterman in his introductory remarks rather excused himself and Mr. Dunning for put-

ting forward the Report, because he said it went over ground that has already been covered by the Reports of the Research Committee of the Institution, but for my part I think they need make no excuse, because, valuable as the reports of the Research Committee are, they are somewhat abstruse for the ordinary mind, whereas the results given in the present Report really come down to bedrock facts and deal with a tremendous number of appliances. The Report does show that gas stove manufacturers do know something about what they are doing.

Ventilation of Gas Fires.

There are one or two small points that have occurred to me. In regard to one of them, Mr. Masterman has already more or less taken the words out of my mouth in his introductory remarks, but I think the sentence in Section I. of the paper, dealing with "Combustion Products and Hygiene"—viz.: "It is to prevent the creation of high temperatures and high humidity that flues should be fitted on certain gas appliances"—is a very important one. That information should be absorbed thoroughly by all those who have to market and sell gas appliances. I am afraid that, owing to the poor state of gas appliances 25 or 30 years ago, it was necessary in the years in between to emphasize the fact that a number of appliances should be properly ventilated, but that concentration on getting appliances ventilated—and I am now particularly speaking of gas fires—has perhaps led us rather too far in the direction of ventilation. The net result is that to-day we are all supplying gas fires which have large entrances into the flue; and when these fires are put up against a chimney which has a good draught we get nothing into the room but the radiant heat, and possibly not all that. The draught is so great that the convected heat is all drawn up the flue with the ventilating air; and it is perhaps unnecessary to emphasize the fact that this ventilating air—if you look upon it as ventilating—is being taken from the wrong part of the room. For my part I would say that gas fires could very well do with a lot less ventilating than they sometimes get.

Recently I have been making some experiments in my own house with quite a small gas fire so arranged that it practically consumes all its products. It has no extra air. I have partially blocked up the flue and blocked up all entrance to the grate, and the net result is that we are using about half the gas we were using previously before we got the room comfortable, and so far as I can see we do not get any ill-effects whatever. The Gas Industry is more and more relying on gas fires to increase its output. If the output is to be increased we must have more gas fires; but the drawback at the moment is that, owing to the methods of fixing, we do not get the full efficiency from them. A coal fire, although having such a low efficiency as 20 to 25 p.ct., is very much less expensive to run than a gas fire, notwithstanding the efficiency of the gas fire is from 50 to 60 p.ct. That is because the initial cost of the fuel in the case of coal is so much less; and if we are really to make gas fires a success we must find some way of increasing the total efficiency. The facts I have quoted show, so far as we can see, that, provided you get rid of the products of combustion, there is apparently no danger with an unventilated gas fire. If we do not take a lot of air away and allow the convected heat to come into the room, we shall do very much better and give a very much more satisfactory article from the point of view of providing, for the cost of fuel, a satisfactory amount of warmth in the room.

An Excellent Apparatus.

Mr. J. W. Wood (Leeds University): In his introduction Mr. Masterman has paid a generous tribute to the work of the Joint Research Committee. While we have in all cases endeavoured to select typical appliances for test there is always the possibility that some individual peculiarity might influence the tests in such a way that generalization would be unsound, no matter how accurately the tests might be carried out. For this reason we welcome the wealth of information now placed before us, obtained from such a variety of appliances. As one who has had quite a considerable personal experience of this class of work I can speak appreciatively of the many hours of labour of which the Report is only a summary.

As regards accuracy, I think Mr. Masterman has been unduly modest. The CO production from a properly adjusted gas appliance is remarkably low; and if we plot CO production against gas rate, there is usually a decided change in direction of the curve when a certain gas rate is exceeded, conditions becoming rapidly worse. I speak subject to correction, but I believe Mr. Masterman has been more interested in determining what might thus be termed the safe limit for appliances, than their very small normal CO output. For this class of work and for appliances like water heaters, where there is no difficulty in securing 5 p.ct. CO_2 and upwards in the flue gases, the simplified CO apparatus described in Appendix 1 possesses ample accuracy, and more elaborate apparatus would be superfluous.

Hygiene of Combustion Products.

In dealing with the hygiene of products of combustion, Mr. Masterman has quoted Henderson's figures for permissible CO concentration. Recent work by Frei, Schwarz, and Deckert, to which a brief reference was made in the 28th Report, would suggest that the situation may become much more complicated than Mr. Masterman indicates in the case of small bathrooms, where we may have to consider CO, not in conjunction with normal air but with a high CO_2 content and correspondingly diminished oxygen supply.

The diagram in fig. 4 of the Report—in which stability of geyser burner flames is indicated at 4 to 6 in. pressure—is of interest to me because at the Cardiff Meeting of the Institution some of my results were criticized owing to the fact that I had worked at the high pressure of 2 to 3 in. water gauge. I would ask whether these stability tests were for single burners in the open or for a number mounted together in a geyser, where draught through the combustion chamber may encourage instability. I gather that flaring may, but does not of necessity, involve a high CO production, one of the few points in which Mr. Masterman's results differ from those of the Joint Research Committee.

Geyser Design.

When the 28th Report was drafted, Mr. Masterman's paper had not appeared, but certain remarks relative to geyser design were made after hearing a paper by Mr. Dunning. As these remarks apply also to the present paper, I will quote them: "It will be remembered that in the 19th Report recommendations were made as to the maximum gas rate, minimum flue length (3 ft.), and the maximum desirable CO_2 content (8·3 p.ct.) in the flue gases for a 2-gallon geyser. During the discussion of the paper these recommendations were criticized. Mr. Dunning showed satisfactorily low CO production without flue pipe, and with considerably higher CO_2 content than 8·3 p.ct. in the exit gases." "Not only the size and type of the gas burners but the size and shape of combustion chamber and flue passages may play an important rôle in determining the behaviour of a geyser; we realize that the results given in our 19th Report refer to a particular geyser—which was, however, regarded as a representative model—and the question of standardizing or enforcing the above limits does not arise."

The distinction between CO production by chilling and CO production due to interference with secondary aeration and free exit of the products of combustion, is a most important one and has been lucidly treated.

The point is stressed in the Report that the amount of CO in the products of combustion from good gas appliances is frequently less than in the streets of large cities. My figure for the air of Meadow Lane, Leeds, is surprisingly good compared with some of the London figures, although the samples were collected at no great distance from the retort house. A block of buildings screened us from motor traffic on an adjacent road. During fogs the value rose considerably.

Novel Method of Stating CO Production.

In the present year a novel method of stating CO production has been introduced—viz., CO production per therm. This is undoubtedly convenient, and will yield comparable results for any one undertaking. I feel strongly, however, that this is not a fundamental relationship, and may give rise to irregularities in comparing gases of widely differing chemical composition. To some extent this is borne out by the CO, CH_4, C_2H_4 experiments noted in the Report. I should like once more to thank Mr. Masterman and his colleague for their excellent contribution to our technical knowledge of gas appliances. The friendly spirit in which the Watson House staff have been prepared to discuss their investigations with us has in no small measure assisted the research work controlled by the Joint Research Committee, and we look forward with interest to further work from the same group of enthusiasts.

Role of Elementary Chemistry.

Mr. J. G. Clark (Gas Light and Coke Company): I am closely acquainted with the information contained in this Report, and I think it is the fact that the work and the data contained in the Report might be regarded as a quite natural development of the fundamental pioneer work that is done at Leeds. As I said previously, we are constantly looking out for pointers to show us the way in difficult pieces of work, and we invariably find them in the experiments carried out at Leeds. Therefore, I think this Report might be regarded as the natural development of that research carried out at the University. One point in the

Report which struck me is how easy it is to avoid some of these evils of bad combustion if we only properly apply chemistry and mechanical design together. It has been my business at different times to examine many appliances. Some of them have been masterpieces of workmanship; whether made in copper or cast iron, whether you look at them as a piece of foundry work or coppersmith's work or anything of that kind. They are masterpieces of workmanship, but they just will not do what they were designed to do, and that is to burn gas! That is where elementary chemistry comes in, and it is surprisingly easy to see how the proper application of chemistry will enable a design which will avoid many of the troubles that have given the Industry causes of complaint in the past.

Co-Operation.

As you will gather from the Report, we are trying to co-operate in every possible way with other centres where this kind of work is going on, and there is undoubtedly room for much more of that. We are constantly discussing things with the technical representatives of the makers so that we can give them the best of our information, and they in return give us the best of theirs, so that the help is mutual and very free. This combustion data, which is the theme of the Paper, is quite a routine job at Watson House now. It has been perfected in such a manner that it is quite easy to apply to new apparatus the tests that are necessary to give us full data. That was not so many years ago; and although in the early stages this was a difficult and tiresome thing to do, it has now been reduced to work that can be carried out very expeditiously, so that it is not too much to expect that any new apparatus can be completely tested and specified in the very fullest possible way. At the same time, I think there is still a lot of work to be done between ourselves and the medical profession. We say sometimes that doctors recommend gas fires, which is true, but we are a little bit dubious when we read accounts of what takes place in the Coroners' Courts, which show such ignorance of the nature of gas and its products of combustion; and I only hope that information such as is contained in the Paper, and others of the same kind, will ultimately tell in that direction. I was interested in Mr. Forshaw's remarks with regard to the relation of ventilation and economical heating. I sympathize with him a very great deal, but I will not enlarge on that side of the subject, because I am sure the authors will have something to say about it themselves.

A Welcome Contribution.

Prof. J. W. Cobb: I have nothing to say by way of technical criticism of the Report. It seems to me an admirable contribution, and the principal reason for my speaking is to welcome it as a contribution of a new kind to our Proceedings. It would be a bad day for our Industry if it adopted the view that the whole of this research work could be carried out by a small central staff of research workers. It is rather the idea that these central researches may be directed towards the solution of a few general and difficult problems of the Gas Industry, but if they are going to be worth anything they should provide the source of many other researches which, in many cases, can be better carried out by the individual gas companies or authorities. This Report is an admirable example of the general thesis which I have just enunciated. Mr. Masterman and Mr. Wood have been in consultation regarding this work, and the outcome of it is, I think, of a specially advantageous character to the Gas Industry. It may be that the results of researches carried out as Mr. Masterman has carried them out, with direct and immediate reference to the daily problems of the Gas Industry, may secure an amount of appreciation which may make us rather jealous, because we quite realize that our own results always come under the sort of stricture that was applied to them to some extent earlier in this meeting, as to the remoteness of their application. But Mr. Masterman's generous recognition, endorsed by Mr. Clark, as to the real meaning of fundamental researches in relation to the researches carried out by the Gas Light and Coke Company—and, we hope, to be carried out by other similar organizations—make it quite plain to the Industry, and the central authority of the University of Leeds welcomes very warmly appreciation of the kind that has come from Mr. Masterman.

I was very much interested in the comments of Mr. Forshaw, with which, however, I do not quite find myself in complete agreement, because at the present time I regard the gas fire as being an example of an appliance which combines two functions in a most admirable way, if properly regulated—viz., the function of a heater and a ventilator—and it seems to me that that is a position which the Gas Industry should be slow to sacrifice. Perhaps Mr. Masterman may have some further comments to make upon that view of the subject.

Mr. T. H. Prater (Margate): I should like to ask if the authors can give us some guidance as to the volume of gas that they consider can safely be burned in a flueless heater per hour, per 100 or 1000 c.ft. of air with a ventilation of two or three times the bulk of air per hour. I appreciate that that can be worked out from first principles, but I thought that if it appeared in print it would be of very great use.

"In the Hands of the Fitters."

Mr. A. T. Gilbert (London): As I have had some experience on this subject I should like to add my contribution to the bouquets which have been thrown towards Watson House. At the same time it seems to me that, with regard to appliances and the products of combustion, we are always in the hands of the fitters. As a matter of fact, there is still on the Watson House district, not very far from here, an old-fashioned, quite 50 years' old, gas fire with ball fuel in use. I think it would be rather useful if they took a sample of the products of combustion in that particular chamber, and hastened as quickly as possible to put in something more up-to-date!

I was very interested in Mr. Forshaw's remarks about the fixing of flues of such large size, because it does seem rather useless when we have a good 50 p.ct. of the useful heat of a gas fire going up the chimney. I happen to know an engineer who advocates having no flues at all, and in the office in which we were shut up all one day he had fixed a gas fire without a flue. I must say that we felt no ill-effects from it. The whole of the fireplace was bricked up, and the gas that was being consumed had a very high percentage of non-combustibles, present with, I think, about 23 p.ct. of CO. If a thing like that can happen, and we did not get any headaches or any sneezing or anything of that kind, then it seems we are going to the other extreme in putting in these flues of very large capacity.

There is one other point I should like to mention, and that is with regard to the question put by Mr. Firth as to whether horizontal or vertical flues had been tested for their efficiency. An experience that came to my notice was in an institution which had been put up at very great expense and which contained a number of nurses' cubicles—about 56 in all. These cubicles had been built so that the gas fires had their outlets into a common flue, the cubicles being back to back. At the top there was the usual form of construction which took the flue serving the two sets of cubicles into a 6 in. flue in the ridge of the roof. That installation was completed after consultation with Watson House and one or two other authorities, and cost some £500 extra because of its design. For the purpose of some alteration work it was necessary for the fitter to light the gas fire in one of the cubicles. This flue was stuffed up with the usual packing material to keep the firebrick of the flue in position; and as a matter of fact this began to flame and smoulder. No notice was taken of it, however, because it was all connected with the one flue. However, in a room next to the cubicle in question, but not connected with the common flue, I found the place full of smoke; and it was found that, owing to the damping effect of the brick leading to the flue in the roof, the smoke fumes were being forced down into the next flue. The architect who was responsible for the job at once pointed out that if this had happened when all the nurses had been in residence and all their gas fires were burning, there might have been a tragedy. This rather suggests that we must endeavour to get out some practical instructions for the fixing of these things, in addition to giving so much attention to getting down to 0·1 p.ct., or two or three decimal places, of CO which may get into the atmosphere under certain conditions. I think the Gas Industry should make some move as soon as possible to regularize both appliances and their fitting; and it is strange that some agitation has not been started after the fatal accidents that have occurred from geysers and other appliances. If we could do that, then Watson House would not be in the position of having a ball fuel fire still in use on their district.

"A Step Backwards."

Dr. A. Parker: With regard to the question of ventilation and gas fires, personally I think it would be a step backwards if the Gas Industry went in the direction of reducing the ventilation in order to increase the efficiency of heating a room, by probably only 2 or 3 p.ct. As far as I understand it, radiant heat is more healthy than convected heat, and the additional heat thrown into a room by reducing the ventilation will be mainly convected heat. If one takes a calm day in summer when there is no wind and the air is perfectly still, you may not have a

headache, but one at once feels a loss of energy and of not being capable of moving about very rapidly without discomfort. I think the same thing applies in a heated room not efficiently ventilated. A movement of air is necessary. It is not merely temperature effect in feeling comfortable. There must be a movement of air, and it more or less acts as a tonic. I also have had some experience of working in a room with a gas fire fitted temporarily without any chimney. It was a fairly large room which ordinarily was heated with radiators, but it was Christmas time when all the staff were on holiday, but I was compelled to be there; and therefore I put in a gas fire temporarily. It was more comfortable than being frozen, because the temperature without the fire was zero, but it was not pleasant. It was not so much that there was smell from the fire, but one felt depressed and lacking in energy. That is important, and we should be very careful before we reduce the ventilating effect in order to increase the heating effect by only a few per cent., and then not in the best direction—viz., by convection instead of by radiation.

Dr. ANGUS: I should like to congratulate the authors on their very valuable paper, but there is one point with regard to gas fires which is not always realized, and that is that we are in the hands of the fitters. I think that far too much attention is given to design and efficiency and far too little attention to the fitters and the way in which gas fires are too often fitted.

THE AUTHORS' REPLIES.

Mr. DUNNING, who replied to some of the questions raised in the discussion, said: The first speaker mentioned the hydrogen in the gas having a beneficial effect on combustion. It is true that the velocity of combustion of hydrogen is about three times that of CO, but this, initially, is not as fast as the combustion of hydrocarbons. Bone has shown that in the slow combustion of mixtures of hydrocarbons and hydrogen or CO, the hydrocarbons burn to CO and hydrogen before any appreciable amount of these gases has started to burn, so that in the initial stages it is the hydrocarbon that gets most of the oxygen, and it is only in the later stages of combustion that we get any appreciable combustion of the hydrogen and CO. The first stage of burning of the hydrocarbons to CO and hydrogen goes forward quite rapidly, but it is burning the final traces of CO and hydrogen that is of greatest importance in the kind of work we are doing. Although we have been estimating, all the time, the CO in the products of combustion, the amount of hydrogen is probably present in similar proportions. The question of hydrogen being combusted in the superheater does not seem at all likely. It is much more likely that hydrocarbons will be broken down with the oxygen present due to the amount of aeration, than that any of the hydrogen will be combusted.

STABILITY OF GEYSER BURNERS.

Mr. Wood raised the question of the stability of geyser burners. The particular tests shown on our curves were actually done in the open without any screening effect or control of the amount of flue gases passing through. With a certain amount of screening such as we get in radiators, we have found the shooting is of the same order as in the open tests, and it was not until we started enclosing our burners and also reducing the amount of air passing over them that we got shooting at lower pressures, as Mr. Wood has suggested; and by comparing the curve we have given showing the effect of using different geyser jets with the other curve for stability, you will see that the instability occurs at a lower pressure than we would expect from our original experiments. Therefore, it more or less bears out what Mr. Wood says, that you can get instability at lower pressures than indicated on that curve. The CO in enclosed radiators is very low even under flame shooting conditions.

As to the question of CO from geysers, and whether any particular geyser is typical or not, it is, of course, impossible to give a typical geyser. For example, we have been doing a large number of tests on one particular design of geyser, and we have been testing a large number of this one particular geyser, all of which are supposed to have been carefully made to dimensions. But even there we found very large variations in the efficiency of combustion, due, perhaps, to a very slight increase or decrease in a particular critical measurement—say, $\frac{1}{8}$ in. here or 1/32 in. there. The point that must be borne in mind is that the gauging of these appliances must be very carefully considered at the critical points of the appliances—*i.e.*, in the flue-ways and in the combustion space. The question was also raised whether the aerated burner is better than the luminous burner in geysers. This has been fought out many times before, and there are advantages with the aerated burner and advantages with the luminous burner. On the whole, however, the advantages are much more in favour of the luminous burner. You can turn the luminous burner down to a much lower rate than the aerated burner; it is much less complicated in design; and you do get a certain amount of auto-aeration with the luminous burner. Providing the flame space is sufficient with the luminous burner, then there is no advantage with the aerated burner. The only reason we need to use the aerated burner is where we definitely must have flame contact in the combustion space.

EFFECT OF CO_2 ON CO POISONING.

The theory of combustion was mentioned by Mr. Forshaw. When we wrote the section of the paper dealing with the theory of combustion we were very conscious that we knew very little about it. A large amount of work has been done on the reaction velocities of the different gases that are present in coal gas, but most of these tests have been done necessarily in enclosed vessels where the effects of the wall of the vessel are often paramount, but the actual homogeneous reaction that we wanted to determine is sometimes very small in relation to the wall effects of the vessel.

Mr. Wood raised the question of the effect of CO_2 on CO poisoning, and whether CO_2 has an appreciable effect on the poisoning due to CO. He mentioned the work of Deckert on that point. Of course, the CO is liable to have an action, because it is the CO_2 that controls the respiration; and if you increase the amount of CO_2 in a room you increase the amount of respiration, and therefore the amount of CO that will be inspired by the subject, and the rate of reaction will be quicker, so that the saturation limits we give will be the same, but the time it takes to reach this saturation will be less.

CONVECTION AND RADIATION.

Mr. MASTERMAN, in the course of his reply, said: Mr. Smith asked whether we had any confidence in any appliance being entirely satisfactory with up to 1 p.ct. CO_2 in the atmosphere, if it were satisfactory in a normal atmosphere. I think I should prefer to say we have every confidence that in the normal amount of CO_2 you may get in a room it will be satisfactory if it is satisfactory under normal conditions. But 1 p.ct. is an extreme case, and we have only done a limited number of tests with appliances up to that concentration. In certain cases it may be that 1 p.ct. will seriously upset matters; we do not know, but we do know that the normal limit of about 0·1 p.ct. is unlikely to have any effect. A number of people have mentioned convection and radiation and ventilation with regard to gas fires, and it has been suggested that a gas fire is a heater and a ventilator. I think the whole controversy is really whether the gas fire is not, in fact, a ventilator and a heater. I quite agree that it should be a heater and, incidentally, a ventilator, and anything that can be done to push up the radiant heat of a gas fire is to the good. We are quite convinced that radiation can be pushed up relatively, and the point is whether it is worth while having some convection component; it is very easily added if one wants it. To assume that the radiation obtained at present from a gas fire is the best we can do is quite incorrect. Mr. Wood has compared the CO in Meadow Lane, Leeds, with the CO in London. I would not suggest that London is a very much worse place than Leeds, as these figures show. The point is that Mr. Wood's figures are taken not in traffic, whereas our London figures were taken in traffic on the London roads; and one can quite well put the difference down to motor car exhausts.

Prof. Cobb made some extremely nice comments about the Report, and I do think there is very much room for both of us. At Leeds they do the pioneer work and are extremely helpful to us in finding new methods which we use. We are not trying to imitate; we are only using Leeds in the way they want to be used, and we carry their work a stage farther, in our turn trying to help the manufacturer of gas appliances, if he has not already got the information he requires.

The volume of gas that can safely be burned in a room was asked about by Mr. Prater. It depends on the size of the room and what it is used for; if it is a nursery or a kitchen, or if there are people sleeping there or not. We have been quite unable to lay down any hard and fast rule at all which in our minds seems satisfactory, because, to start with, the ventilation is the important thing, not the size of the room, and what people are doing in the room. If they are cooking, they are very unlikely to suffer any ill-effects as compared with if they were sleeping there, if anything goes wrong, so that we have only rough and ready rules. Every case must be taken on its merits. With regard to ball fuel in an installation quite near this

meeting hall, I am very sorry about it, but what we have tried to do in the Report is to link up what in the case of ball fuel may lead to CO production. Why is ball fuel worse than column fuel? There is a reason, and we have tried to make the reason clear. If it has been made clear, I feel to that extent the Report has been justified. The depressing effect in an unventilated room containing a gas fire, I suggest, is shared by an unventilated room containing a hot water radiator. I do not think it is anything to do with the gas fire as such. I think it is a ventilation effect, and I think it may be a black mark against central heating.

I am afraid I have not dealt with all the points raised, but I think I have dealt with most of them, and I would add that we are extremely grateful for your very kind reception of this paper.

Disposal of Liquor Effluents from Gas-Works and Recovery of Ammonium Chloride from Circulating Liquor

First Report of the Liquor Effluents and Ammonia Sub-Committee

Mr. CHARLES F. BOTLEY (Chairman of the Sub-Committee): I only wish to offer a few observations of a more practical character. First of all, I want to remind you that we have now a combined Committee for liquor and effluents, whereas before we had separate reports. Although this is the first Report of the combined Committee there have been a number of other reports prepared and issued in previous years. A year ago when we met the sulphate of ammonia market was very bad, and what we might say of it to-day passes words of expression. The result has been to create a very critical position in many undertakings with regard to the disposal of ammoniacal liquor. The Committee have felt it desirable that they should give some attention to the disposal of crude liquor as compared with waste or spent effluent, and there are means of disposing of crude liquor which can be used, but any haphazard methods of disposal may have very unpleasant results and may cast discredit on us who are working at the problem. Therefore, on behalf of the Committee, I deprecate most strongly any haphazard methods of disposal of crude ammonia. On the other hand, I offer, on behalf of the Committee, assistance to any member within the resources of the Committee, should that member wish to have information on the particular matter of disposal. I have mentioned this rather emphatically because it has been sometimes suggested that we are losing our vocation. We are, after all, a Research Committee, but if we have to run off the track just a little to help somebody in difficulties, we are still on the main line of research, and we have progressed to quite a satisfactory point. We have got to grips with the problem of research and we have been greatly helped by those who have worked on this matter in the past, Dr. Parker and Dr. Monkhouse, and now we have Dr. Key. I will leave the details of what we are doing in more able hands, but it will suffice for me to say that at the present time, among other things, we have no fewer than three methods of recovery of ammonium bicarbonate before us. We have one or two methods of disposal of trade effluent, and we have a process for making of ammonium chloride. These, of course, are alternatives to the manufacture of sulphate of ammonia, and we do not want to get into the habit of thinking that we shall not want any sulphate in the future, or that we should leave it to certain combines to make sulphate. At the same time, every avenue must be explored, and I only hope that we shall be successful in showing methods as alternatives to the manufacture of sulphate.

Mr. F. R. O'SHAUGHNESSY (Chief Chemist, Tame and Rea Drainage Board): I thank the President and Council for their invitation to attend this meeting, and the Secretary for his cordial invitation to take part in the discussion of the First Report of the Liquor Effluents and Ammonia Sub-Committee. I would congratulate the Sub-Committee on the excellent work which is being done on behalf of the Gas Industry with a view to recovering materials like the phenols, sulphur, &c., before passing the liquor forward to the sewer. All such materials tend to increase the load on the sewage treatment plant; and as many of the constituents of waste gas liquor are quite foreign to natural sewage, experience shows that the limits of the quantities of various components of the waste gas liquor which may be tolerated by the sewage treatment plant are very quickly reached. Consequently the sewage expert notes with pleased appreciation the success which appears to be attending the experiments carried out by your experts in this direction of recovery as recorded in this Report. I have evidence that some of the constituents of the waste gas liquor are particularly resistant to biological oxidation, and this is more pronounced in the liquor from vertical retorts. At present I have been unable to identify the offending material, but further work will, it is hoped, reveal it. It is possible that the neutral bodies—the tar oils—may be responsible for it; and in this regard the remarks in the Report indicating that a research for a special solvent in the crude tar are of particular interest to me.

"DILUTION."

Two years ago, in a discussion at the Royal Sanitary Institute on Trades Wastes as affecting sewage treatment, Dr. G. McGowan, lately Chemist to the Royal Commission on Sewage Disposal, stated that the significance of trades wastes as affecting the problem of sewage disposal might be summed up in the word 'dilution; and I am in general agreement with that view. It will be remembered that statements regarding the percentage of gas liquor which might be tolerated in a sewage have varied somewhat from time to time. The changes which have taken place in gas-works practice, with resulting changes in the strength of the liquor produced, are in part responsible for this. Recent work, however, has shown that the greater concentration of impurities in modern gas liquors results in a substantial reduction in the volume of the waste gas liquor which is tolerable in a sewage, and a further consequence has been that relatively small variations in the percentage volume of gas liquor in the sewage caused trouble in the sewage purification plant. It is easy to see, then, that unless great care was exercised in regulating the discharge of waste gas liquor to the sewer another important factor which gave rise to confusing statements was here.

Recent carefully controlled investigations have helped to dispel this confusion by giving definite results with accurate information as to the conditions. It seems, however, that there is now a tendency to minimize the problem represented by gas liquor in sewage, and I would point out that, in the interests both of the Gas Industry and also of authorities who are responsible for sewage purification such an attitude is to be deprecated. So long as waste gas liquors are produced whose oxygen figures range up to some hundreds of parts per 100,000, these must always be regarded as presenting a serious problem to sewage purification authorities when admitted to the public sewers.

UNJUSTIFIABLE GENERALIZATION.

My experience leads me to insist that it is altogether unjustifiable to generalize about the amount of gas liquor which may be admitted to sewage in general. Each case must be considered on its merits, for experience reveals a number of variables.

The character and strength of the gas liquor, the nature of other trades waste in the sewage, the type of plant at the sewage works, and the presence or absence of skilled control at the purification plant must all be taken into account.

Similar remarks may be applied to the proposal which is now under consideration by many localities to pass the whole of the crude gas liquor (containing all the ammonia) to the public sewers. The waste of so much valuable material can hardly be countenanced with equanimity, and one hopes that the efforts of the Research Sub-Committee to convert this ammonia into a form available for commerce will meet with the success which they deserve.

Respecting methods of treatment, the results of the work done on the beds at Coventry are of the greatest interest and importance. It must be pointed out, however, that the behaviour of these beds is in accord with results obtained by myself, and serves to show the decided limitations of this procedure. The method must be regarded as very expensive. Alternatively the destruction of the im-

purities present in the gas liquor is greatly expedited when mixed with sewage and treated in an appropriate manner, this being due to certain bio-chemical principles.

The fact stated in the Report that, when crude gas liquor was treated on the Coventry filters the ammonia was not oxidized in the filters, is again in accord with my experience.

Broadly, one may put the position as regards admission to the sewage of the waste gas liquor as follows:

No one would contend that the admission of (say) one gallon of waste gas liquor to a million gallons of sewage would make any difference; on the other hand, any attempt to treat the gas liquor alone, as, for instance, by the method of the Coventry filters, is both expensive and unsatisfactory. There is obviously some point between these two extremes which is both reasonable and tolerable, the amount in any particular case being governed by the various conditions indicated above.

Extraction of Phenols.

Mr. A. L. Holton (Manchester): While agreeing that the use of crude benzole would be effective, it must be remembered that if the phenols were recovered by distillation (as at Partington) the heavy hydrocarbons from the benzole would remain in the crude phenols (*i.e.*, until they had been eliminated from the stock). The quantity so lost would appear to be at least the "160°-195°" and the "above 195°" fractions, which total 13·2 p.ct. of the original benzole. The greater quantity of sulphur compounds in the crude benzole (as compared with, say, 90°) might have some effect on the carbon filters, though not necessarily harmful.

In the Report it is stated that "the chief factors controlling the efficiency of operation are shown to be the temperature and height of the washer." Reference is also made to temperatures of 60° C. (as compared with 45° C. at Partington). This may account for the greater loss of H_2S. (The Report gives 45 p.ct.; Partington shows 33 p.ct.) The loss of benzole—concluded in the Report to be ½ gallon of benzole per gallon of phenols recovered (*i.e.*, loss in washed liquor)—appears high. The figure at Partington is only about half that amount, before the carbon filters.

In Table IV. giving the results of static laboratory experiments on the extraction of phenolic bodies by solvents, the tar oil fractions could not be separated from the phenols by distillation, owing to the proximity of the various boiling points. The use of benzole and tricresyl phosphate also would make recovery of phenols by distillation very difficult. The Report suggests that phenols could easily be recovered by distillation if tricresyl phosphate were used alone. But would not distillation leave in the tricresyl phosphate the pitch, tarry matter, &c., associated with the phenols in the liquor, and so gradually make the phosphate unfit for use? Soda washing for the recovery of the phenols would appear to be possible—but even that would not entirely prevent contamination of the tricresyl phosphate. What is the loss of tricresyl phosphate involved in the process (*i.e.*, in addition to that dissolved in the liquor)? It would appear that these factors, together with the initial cost, would prevent the use of tricresyl phosphate becoming a commercial proposition.

The "phenols extracted" by 90° benzole as given in Table IV., item 2, appear low even at 60° C., but this is probably due to the insufficient height of tower, as stated. According to the Report, it is inferred that "Use of benzole as a solvent does not materially diminish the higher tar acid content," but later the extraction of higher tar acids is quoted as amounting to 30 p.ct. and it is stated that with a higher tower it would probably reach 39 p.ct. At Partington the figures (based on O/A) show a reduction of about 25 p.ct. The Report states that experiments indicate the presence in the tar of some substance which should be very effective in removing phenols and the higher tar acids. Is this compound one of the bases (*e.g.*, pyridine, quinoline, &c.) which have already been suggested as solvents?

Soda Washing for Phenol Recovery.

Dr. A. C. Monkhouse: I am very interested in this Report owing to my close association with the work, and I should like to thank Dr. Key for the very kind remarks he has made. I am sure he is to be commended on his industry and his grasp of a subject which covers such a very wide field. The reduction of the higher tar acids in the liquor by the method of segregation of the retort house tar as practised at Coventry and experimented with at Hinckley, combined with a removal of monohydric phenols by solvents such as benzole, does appear to a very large extent to be a solution in cases where the removal of such constituents is necessary. It is very gratifying to hear of the results of Mr. Holton's plant at the Partington Works, and his preliminary figures show a very high efficiency of removal. The economics of the process as shown after longer working will be awaited with interest. I think it would be an advantage if Mr. Holton would give, in his contribution at a later date, the reasons for adopting the distillation method of recovery of crude phenols from the benzole-phenol mixture. In the majority of the German plants I have visited, soda washing methods were adopted and the various reasons for and against are given in the 5th Report of the Effluents Committee. Has there been a change of opinion, or is it connected merely with the Partington case?

Reverting to the present Report, at Hinckley it was found possible to work with a dry ash pan when destroying liquors by means of the producer bars. At the same time I think you will agree that this is not a normal condition of working producers, and it would be very difficult to attain a dry ash pan unless constant attention is given. There is also another point—viz., is there any disadvantage in this method of working if the clinker is used later for block making? The putting of ammonia liquor containing ammonium chloride on producer bars must mean either the formation of hydrochloric acid or undecomposed ammonium chloride, and these might find their way into the waste gas flue. Have any figures been obtained on this point, and what would be the effect on a waste-heat boiler if such a system were used? Factors like that will have to be considered in connection with the installation of waste-heat boilers, and I should like to know if any figures have been taken out with regard to the hydrochloric acid getting into the flue gases.

Efficiency of Washer.

Mr. F. Firth (Leeds): In a report of this character the only comments one can logically make, in the absence of having done similar work, is of the interpretation of the observations made and the experimental data obtained. Table IV. gives the distribution rates, tar acids between liquor and solvent, when the conditions represented a one-chamber washer, which admittedly is most unfavourable to a good distribution ratio; on the other hand in Table V. the results recorded are those where counter-current conditions have been employed and which should be much more favourable to a good distribution ratio; but if we examine the figures for the same solvent, when used in each case, the figures quoted in Table V. are little better if any than those in Table IV., and the conclusion these results would suggest is that the washer is not very efficient.

The author's statement that "neither the ratio of the flow of liquids nor the ratio of solvent to liquor are important factors in the extraction of the tar acids, but that doubling the height of the washer has practically the same effect as washing the liquor twice with solvent" would appear to be consistent with assuming the counter-current washer was in effect little better than a one-chamber vessel; consequently the figures given in Table V., though comparative one with another, will not indicate the possible results obtainable, given efficient counter-current conditions. The difficulties of washing one liquid by another and the difficulty of overcoming their surface tensions is a problem which will require the greatest of ingenuity to overcome; and I would suggest that an alternative would be to remove the tar acids from the gas before they could be dissolved in the liquor, and eliminate the necessity of liquor washing, which, even given a successful washer, would necessitate recovering from the washing liquor the dissolved solvent either by evaporation, which is bound to be expensive owing to the volumes involved, or by passing through active carbon filters. If the latter method is used, why not use it in the first instance to remove the tar acids, and eliminate the use of solvents?

To remove the tar acids from the gas while in the gaseous or fog state before being carried forward and dissolved in the liquor would require a hot tar washer in the position now occupied by the cyclone tar extractor and worked at a temperature of 72° to 75° C. The washing cycle could be a similar one to the usual continuous extraction plants, and from experience we know that gas washing on counter-current principles can be very efficient. The possibility of success can be gauged by the figures given in the Report, which show that the 3 gallons of tar per ton of coal carbonized which is deposited in the cyclone tar extractor is washing out of the gas 21 p.ct. of the total oxygen absorption bodies which otherwise would be found in the liquor. In the experimental washing plant treating the liquor, the solvent used will be approximately 30 gallons per ton of coal carbonized. I would like to congratulate the authors on the amount of work they have put into the preparation of this Report, which is most instructive and will be a very valuable addition to the work already done on this research.

Effluent Disposal.

Dr. A. Parker: I have not anything to add to the technical side of the Report. I have gone through the

Report as a member of the Committee, and agree with it; but I would like to remind the members of how the problem has developed. The Report deals with the disposal of effluent liquor, the recovery of ammonia, and the disposal of ammonia liquor; but there is a whole history to the thing. In the first place, the Effluent Committee was formed because of the difficulty of disposing of effluent liquor in the manufacture of ammonium sulphate. That Committee has been working for some time, and, I believe, with very satisfactory results. In fact, I think we might almost say that for most works making sulphate of ammonia, there is some method of dealing with the disposal of effluent liquor fairly satisfactorily. The methods are not the same for every works, but satisfactory methods have been tested by the Committee and have been reported on.

We then come to the problem of the manufacture of sulphate of ammonia at a cost which will not incur a loss, and so the Ammonia Committee set to work to deal with methods of recovery of ammonia. That is a much more difficult problem. It is a problem which has been studied by people all over the world for many years. Prof. Cobb has a process which for certain reasons has not been commercially successful. Burkheiser, Feld, and others have had processes, and it is a difficult problem for the Committee; but they are dealing with it, as you can see from the Report. At the same time, I should like to put forward a plea that those in the Gas Industry with facilities should try experiments on their own account. The Research Committee, as already mentioned to-day in connection with other Committees, cannot do the whole of the research.

Cheapened Recovery of Ammonia.

In the recovery of ammonia, I think that when a cheaper method is found later it will be as the result of a bright idea occurring to somebody and then that idea being followed up and worked out. There is plenty of scope for cheapening the recovery of ammonia. When the loss on ammonia becomes so great, people will have to consider the disposal of ammonia liquor; and then we shall have another serious problem, but that should be looked upon as a last resort, because it is a very different problem from the disposal of effluent liquor. It contains chloride associated with ammonia and not lime, and it is therefore an easily volatilized chloride and may give rise to trouble in certain methods of disposal which have been proposed. In addition, crude ammonia liquor contains sulphuretted hydrogen. In the manufacture of sulphate, all sulphuretted hydrogen is removed when the ammonia is distilled off and the devil liquor is condensed. The sulphuretted hydrogen is removed by oxide or other method, and that problem has to be considered. It may give rise to difficulties, and therefore one has to be very careful before recommending definite methods of disposal, for crude ammonia liquor. It is a different problem from the disposal of effluent liquor, and I would like to issue a warning that the real method is to try to cheapen the recovery of ammonia.

Mr. Holton has brought forward some useful information obtained in operating his plant for the recovery of phenol. I am hoping that when he has gone further he will be able to give more figures, because after so short a period of running he cannot tell us what is the best carbon to use, and what the cost in carbon is likely to be. Active carbon is a very funny thing. In connection with water purification you find that whenever taste troubles, due frequently to phenols and other substances, cannot be removed by chlorination, along comes active carbon, and the work so far carried out seems to show it is likely to be more successful. On the other hand, others come along and say they have tried active carbon and it is not successful. Whether it is due to a difference in the substance to be removed or not, I do not know. In this present case we have phenol recovery. One of the first methods put forward in this country was to remove phenol by passing the liquor over activated carbon. That method was experimented with by Dr. Parks in this country and others on the Continent. In Mr. Holton's producer he tries to reduce the loss of benzole by active carbon. Can Mr. Holton tell us anything at this stage—it may be too early a stage—in regard to this point? A certain amount of phenol remains in the liquor after washing with benzole. Then the liquor containing benzole is passed over activated carbon to prevent loss. Is the activated carbon accumulating in its pores quantities of phenol and other tarry bodies which are not removed in attempt to revivify the carbon? Is that accumulation so serious as to be likely to interfere with the life of the carbon and make it costly?

Getting Rid of Crude Liquor.

Mr. T. H. Prater (Margate): There is no doubt that the whole of the Report we are considering is extremely valuable, but most of us will give the greatest attention to the portion dealing with the disposal of effluent and crude liquor through the producers. The Committee has set before itself the correct ideal as we see when we read, in the General Introduction, "The Committee has, however, given most of its attention to the utilization, and not the destruction, of NH_3." Yet if one would criticize the Report it would be to say that the need of the moment for gas engineers is to discover some way of avoiding the serious loss on the production of sulphate with which we are at present faced. This loss will not be removed by any income from the sale of recovered phenols, nor will the position be greatly improved by turning over to ammonium chloride manufacture, as the 3000 tons of this salt we import would very soon be supplied, and then the supply would exceed the demand and we should suffer a loss again.

Not many works which are already making sulphate are having great difficulty in disposing of their effluent, and now that many works have ceased the liberation of fixed ammonia by liming, it is interesting to read that no trouble has been experienced in treating this effluent. But even this has cut the losses by only about 40 p.ct. In most cases where permission has been sought to pass the crude liquor down the sewers, this permission has not been granted. Although at my works we stopped liming more than a year ago, yet it was for less than three months that this served to cut our losses, such as the tumble in the price of sulphate. As the result of research work we have now not only cut our losses, but are, so we think, actually making a slight profit. For some time now it has been American practice to crack surplus synthetic ammonia into hydrogen and nitrogen. The cracked ammonia is bottled and used for welding when the nitrogen also present has little effect, owing to its low heat capacity. This feature, together with the fact that less ammonia is produced from horizontal retorts, probably due to decomposition by radiant heat, led us to experiment with the cracking of ammonia in vertical retorts and producers. After considerable laboratory and experimental work on a single retort, we have now for some months been disposing of the whole of our free ammonia without the production of sulphate. The process has been so successful that on outside advice we have deemed it wise to protect it in the names of my chief, Mr. J. M. Campbell, and myself. This process is known to Mr. Botley, the Chairman of the Committee, whose report we are discussing, and has also lately been inspected by their research chemist, Dr. Key, who may, perhaps, make his comments when he replies.

Mr. Chas. Cooper (W. C. Holmes & Co., Ltd.): I will confine my remarks to some points of immediate interest in Mr. Holton's account of the operating results on the dephenolating plant at Partington. It appears to me that the apparent benzole losses would be lower if the benzole purchased in future was such as would approximate in composition to that now circulating in the plant. I would like Mr. Holton's opinion on this. With losses so low it appears to me that the tricresyl-phosphate method can hardly be expected to show any advantages. Even the losses reported by Mr. Holton, which are, in fact, lower than I have already seen figures of, cannot perhaps be treated as complete losses. Most of the benzole which passes through the filters would re-appear in the gas in the semi-direct method of working adopted at Partington. Similarly the benzole residues found in the final tar acids should realize some revenue when handled by the refiner of tar acids. In regard to a later section I would mention a case where the clinker removed from a producer in which there had been some crude liquor evaporation was unsuitable for the purpose of mortar making, which was undoubtedly due to its contamination with salts.

Dr. Key Replies.

Dr. Key, replying to the discussion, said: I should like to ask permission to reply in part to the discussion in writing later. I was pleased to have Mr. O'Shaughnessy's contribution. I know what he thinks about the matters on which he has spoken, and I agree with him in all things. He seems to be under a slight misapprehension, however, with regard to a statement of the Report. He apparently thinks that we are already putting the ammonia liquor on the bacteria beds at Coventry. Actually, of course, the results reported are not for ammonia liquor, but for spent liquor which, however, has not been limed and therefore does contain ammonia, but in the form of ammonium chloride. I think also he said he was puzzled as to what the offending material was in the vertical retort liquors which were very resistant to physiological observation. I think that it is very likely those higher acids which are, in the main, the distinguishing feature of vertical retort liquor as against horizontal retort liquor. Mr. Holton has been good enough to send me a copy of his remarks on his de-

phenolating plant, and these give us a first account of a large-scale phenol recovery plant operating on what may be regarded as typical vertical retort liquor. It is instructive for its own sake and also as confirming some of the conclusions drawn from the work reported this afternoon. For instance, we say in the Report that "liquor from British gas-works is at least as susceptible to phenol removal as German coke oven liquor." The 90 p.ct. removal obtained at Partington is sufficient confirmation of this. Again, the general conclusion of our Report is that benzole will not remove higher tar acids to any large extent. Mr. Holton finds his figure to be about the same; he finds the difference figure of the oxygen absorption reduced by 27 p.ct.

A rather surprising fact brought out in Mr. Holton's table of analyses is that neither the phenol content nor the higher tar acid content is appreciably affected by the passage of the liquor through active carbon filters. Mr. Holton states that with the present high efficiency obtained, no drastic improvement in the working of the plant can be expected. That is true enough as far as the efficiency of removal is concerned, but I think attention to one or two factors might appreciably reduce the cost of working. The first is the proportion of benzole to liquor. Mr. Holton uses 60 to 70 p.ct. We have found the efficiency of extraction not to be very greatly dependent on the proportion of benzole, provided it exceeded a minimum—in our case 43 p.ct. If Mr. Holton used this amount, his distillation costs, which constitute the largest single item in his expenditure, should be reduced in proportion—say, by 30 p.ct.

Use of Crude Benzole.

Another point is that Mr. Holton uses benzole at 1s. 8d. per gallon. We have found crude benzole costing much less than this to be as efficient as the more refined product. Its adoption in this case would considerably reduce the cost, but not the amount, of the benzole loss. It may be, of course, that crude benzole would foul the active carbon or alter the composition of the recovered phenols, and this could only be found by trial. I will reply further to Mr. Holton in writing. I think, however, that most of his criticisms can be explained by simply reading the Report in relation to its context. For instance, Mr. Holton mentions tricresyl phosphate and asks for information concerning it. He wonders what the loss would be and how phenol would be recovered. In the Report it is stated distinctly that we ourselves have not investigated this substance yet, although we hope to do so. Similarly, Mr. Holton compares the statement in the Report that we should not expect any appreciable diminution in the higher tar acid content by benzole washing, with the later statement that we do get quite a considerable diminution. The first statement is stated to be deduced from our laboratory experiments on catechol, which we took as the simplest chemical compound which could be regarded as representing the higher tar acids. Our conclusions were from this alone: but it is said later that these conclusions have to be modified in view of our experiments with the counter-current washer on actual ammonia liquor.

I am sorry Mr. Prater did not have more time to discuss his process, which seems to give him every satisfaction. I must point out, however, that the adoption of this system means that the best thing to do to-day is to destroy the ammonia produced in the carbonization of coal; and that is a conclusion I am not prepared to subscribe to. Even if it were concluded that the ammonia should be disposed of in some such way, I think a simpler way of doing it will be found without going to the trouble of cracking it in vertical retorts.

Written Communication.

In a subsequent written communication, Dr. Key states: Mr. Holton suggests that the temperature of 60° C. employed in the experimental washer might explain the greater loss of H_2S, which is 45 p.ct. compared with 33 p.ct. at Partington, where the temperature is only 45°. This is not the case. The extraction of sulphide is not discussed in detail in the report, the value of 45 p.ct. being given as a maximum. A reference to Table V. shows that this was obtained with a liquor containing very little sulphide. The average sulphide removal by crude benzole was 27 p.ct., rather less than is obtained at Partington.

The loss of benzole estimated in the report was calculated assuming the liquor to be saturated with this substance. It was considered reasonable to assume that, if the washing were efficient enough to remove all the phenol from the liquor, it would be efficient enough to remove as much benzole as possible to the liquor. Mr. Holton's statement that this is not the case in actual practice is surprising but welcome. Actually, from Mr. Holton's figures the liquor from the washer would appear to be 70 p.ct. saturated with benzole.

Mr. Holton raises several pertinent questions regarding the use of tricresyl phosphate as a solvent for phenols. As is stated in the report, most of our information on this substance has been obtained from a paper by Schonberg, and we have yet to make an investigation on the subject. It would be rash, however, to conclude immediately that the factors mentioned would prevent the use of tricresyl phosphate on the commercial scale.

An investigation is in progress on the properties of tar oils in relation to phenols, and information has already been obtained on the importance of bases which, it was suggested, might be responsible for extracting phenols from liquor. A complete reply to the suggestion cannot yet be made.

It should be stated in reply to Mr. Firth that the experiments recorded in Table IV. were not carried out to find the performance of a single chamber washer, but in order to ascertain what were the ratios of the concentrations of phenols in solvent and liquor at equilbrium. Such equilibrium would never actually be attained in practice, but the information is useful for comparing solvents and for finding the proportion of solvent it is necessary to use for counter-current washing. The experimental plant was used to find the velocity of extraction, and not the equilibrium, and it is a coincidence that the percentage of phenol extracted in it by crude benzole is approximately the same as obtained in the laboratory equilibrium experiments. The reason the experimental washer is not more efficient is because of its small height. With double the height available for washing it is calculated that 88 p.ct. of the phenols would be extracted.

Mr. Firth suggests that a hot tar washer in the position now occupied by the cyclone tar extractor would remove tar acids from the gas. This is a useful suggestion but by no means new, since a patent has been granted on the subject. In support of his suggestion Mr. Firth points out that the amount of tar which would be needed would probably be much less than the amount of benzole required in plants where this substance is employed. It must be remembered, however, that the amount of benzole in use is not the main factor (except where the phenol is recovered by distillation—see spoken reply to Mr. Holton). The important point is how much of the benzole is lost; and this quantity can be made very small by suitable methods of recovery.

Mr. Cooper was quite right when he stated that at Partington part of the benzole lost was introduced into the gas stream. This can only be the case when the semi-direct process is in operation. Even then it must be regarded as a partial loss, since no one would be willing to pay 1s. 8d. per gallon for benzole to be used for carburetting gas. The same remark applies to the benzole contained in the phenols.

The Margate Process.

Mr. Prater gave us an interesting account of a process of ammonia dissipation in operation at Margate. The ammonia is apparently completely cracked to nitrogen and hydrogen in the retorts, and is thus converted into combustible gas. The process necessitates distillation, which, however, on works with a plentiful supply of waste steam, may cost little. The distillation must be carried out in or near the retort house. The dilution of the coal gas with nitrogen and hydrogen must lower the calorific value, and therefore less water gas will have to be added. The steaming must be reduced somewhat, and there will be a saving of coke. On the other hand, if the C.V. of the cracked gas is less than that of water gas (say, 300 B.Th.U. per c.ft.) a less total volume of diluting gas will be required, and the therms per ton of coal will be reduced. This must be balanced against the coke saved. The actual C.V. of the cracked gas cannot be calculated. That of the cracked ammonia will be about 230, but this will be modified by the presence of CO_2 originally dissolved in the liquor (which will be partly reduced to CO in the retort) and by some of the volatile phenols from the liquor, which will also have been cracked in the retort. The probable profits of the process, if any, are obviously very small, and will certainly be very soon turned into a loss if the cost of distillation is appreciable.

The comments of Dr. Parker and Dr. Monkhouse were helpful and useful, but were not in the form of criticism or questions, and therefore need no answer. I should like to emphasize, however, what Dr. Parker and others have said—that the real solution of the ammonia problem is to try to cheapen the recovery of ammonia.

Street Lighting

First Report of the Committee

The CHAIRMAN (Mr. Ralph E. Gibson): The question of street lighting has been very much to the fore lately. It has been thought that we gas engineers did not give sufficient attention to this matter, and that in many places the claims of gas for street lighting were not being put forward as they should be. This Street Lighting Committee has done very good work. The recent International Illumination Congress has awakened much interest; I believe the Institution was very well represented at the various conferences, and that the claims of gas were well put forward. I think we must all be very proud of the magnificent street lighting by gas that we see in London, and especially the brilliant lighting of Whitehall, which represents the last word in the gas lighting of streets.

I will ask Mr. Copp, who was Chairman of the Committee, to introduce the Report.

Mr. HAROLD COPP (Past-President of the Institution, and Chairman of the Street Lighting Committee): I was Chairman of the Committee on account of the fact that at that time I was President of the Institution. As you know, Mr. Watson, the Vice-Chairman of the Committee, has made a very special study of street lighting. I was a member of the Lighting Committee of the British Engineering Standards Association; a number of its members are not able to attend, but Mr. Watson has been very assiduous in his attendance at its meetings and also at the meetings of the Institution's Street Lighting Committee. I think the reason for the formation of our Street Lighting Committee was that many of us realized that gas was facing rather stiff competition to retain the street lighting of the towns of this country, and it was thought that the Committee might be able to assist particularly the smaller undertakings in towns where perhaps they had not put up the fight they might have put up to retain the gas street lighting. Unfortunately, in a number of towns recently the authorities have practically decided to substitute electricity for gas lighting, irrespective of cost; and I think that is one of the saddest features of the whole problem, because we have not had fair treatment in a good many places. This Committee has power to add to its membership, and it affords an excellent example of the value of the co-operation of manufacturers; quite a number of manufacturers of gas appliances have joined the Committee, and have done very valuable work.

COMPETITION IN HULL.

I think it may be said that, until a few months ago, our progress in street lighting in this country had not been as satisfactory as it should have been. We have had a magnificent example of enterprise by the Gas Light and Coke Company, and no doubt a great many of you have noticed that the fight has been proceeding on quite a large scale in the City of Hull, where my Company supplies. The Corporation there decided some time ago to convert the whole of the street lighting to electricity. We came to the conclusion, however, that we could give them better value for their money with gas lighting, and that we could also save the City a very large expenditure. With the assistance of the National Gas Council, we won the first round, in that the Ministry of Health refused the Corporation sanction to borrow the £70,000 or £80,000 required to meet the cost of conversion from gas lighting to electric lighting. As the outcome of that, we have put up four examples of what we think public lighting by gas should be; we have taken a leaf out of the book of our opponents and have tried to make the best use of reflectors for directional lighting. I think everyone who is not prejudiced would admit that the lighting we have provided is vastly superior to that given by electric 100-watt lamps; the tests show that it is practically twice as good. We also came to the conclusion that the gas for public lighting should be supplied at the very minimum price, and our price for gas for public lighting now is in the neighbourhood of 5d. per therm. The real cost price is a debatable matter. I have discussed it with Mr. Bloor, of York, who is very interested in that aspect of the problem, and I think he agrees with me that, of all gas prices, the price of gas for public lighting should be absolutely the lowest.

I have with me some results of tests of the experimental lighting installations we have provided at Hull, and it is very interesting to note the effects of the different types of reflectors. It is possible practically to double the amount of light at the angle at which we particularly want it—*i.e.*, generally in the neighbourhood of 10°, the best angle for increasing the minimum illumination at any point between two lamp-posts. Another point is that the size of unit of light has a direct relationship to the height at which it should be mounted. That is set out very clearly in this first report of the Institution's Street Lighting Committee, and it is emphasized also by the Lighting Committee of the British Engineering Standards Association. If anyone is sufficiently interested I shall be glad to hand them copies of the test results obtained at Hull. Tests have been made by three independent authorities, and their results agree very closely, so that if a final decision is taken on the relative intrinsic merits of gas and electricity I am quite sure the streets will continue to be illuminated by gas.

OBJECTS OF THE COMMITTEE.

Mr. ROBERT WATSON (Vice-Chairman, Street Lighting Committee): Mr. Copp has taken a very keen interest in this work. For many years he has interested himself in gas lighting, and his interest has been the greater perhaps in consequence of the work he has been doing at Hull. We all sympathized with him; he was up against very severe competition in that City, and we are exceedingly glad that he has been successful so far in maintaining gas lighting over the greater part of the area. I have seen some of the figures obtained in the Hull tests, and had been hoping that Mr. Copp would have given them at this meeting, but he has made them available to any who desire to see them.

The object of the Institution in forming this Committee, I understand, was to consider means of developing the technique of, and the plant used in connection with, gas lighting in the streets. At one of the early meetings it became obvious that the first consideration was to make an appeal to all those responsible for gas lighting throughout the country to exercise greater care in improving and maintaining the efficiency of their street lighting installations. The Committee were well aware that in many cases the gas lighting in streets was excellent and left nothing to be desired. Unfortunately, that is not general, and while during this autumn we have been in the happy position of showing our visitors from overseas, who were attending the International Illumination Congress, some excellent examples of street lighting, had they chosen to visit some districts one could think of they would not have agreed that efficient gas lighting was general. It was for the purpose of making an appeal to those who have not felt it necessary to improve their street lighting by gas that the Committee have prepared and now submit this Report. It is not long or elaborate, and members of the Institution may feel that many things have been omitted; but this is probably the first stage.

THE B.E.S.A. SPECIFICATION.

It is, as you are aware, based on the provisions of the British Standard Street Lighting Specification, and the main criterion for the evaluation of street lighting on that Specification is the minimum foot-candle value at approximately the mid-way point between adjacent columns. The Committee were aware that that basis is not universally accepted, but it is a convenient and simple one for the purpose of improving the distribution of light in streets. A preference has been shown by some for average horizontal illumination, averaging the illumination from a post to the mid-way point between it and the adjacent post, but there are so many ways of arriving at average illumination that difficulties present themselves. I have known cases in which the average illumination has been thought to be half the sum of the maximum light and the minimum light in the span, which, of course, is absurd. When point-to-point testing from column to mid-span is adopted, disagreement may arise and different results may be obtained according to the number and position of those points. It is extraordinary that by the simple device of lowering the light source, which is against good distribution, one can improve the average and obtain a worse effect at the minimum point. There are difficulties of that sort; and there are some people, of whom I am one, who consider that for general purposes the minimum foot-candle basis of appraisal is quite a good one. At any rate, the Committee have adopted that Specification, but that adoption does not commit anyone so far as one's views are concerned.

There is the point that compliance with the provisions of the Specification does produce improved results. It makes for better distribution of light from column to column; and in view of the fact that there are a clause which stipulates against any abrupt change in the light at any point between the column and the midway point and provisions for increased mounting heights and closer spacing, it makes for better visibility in the streets and

helps to improve lighting generally. I consider personally, and I think the Committee will agree with me, that the Specification has helped us in the Gas Industry so far as street lighting is concerned. The increased mounting heights stipulated by the Specification not only increase the mid-span illumination, but also bring into play the maximum rays, which we derive from an inverted burner at an angle of 40° or 50°, over a greater portion of the area. We have been at a disadvantage in connection with inverted burners because we do not get any appreciable gain from the distributed light at an angle of 80°; our maximum rays are at an angle of 40° or 50°, and the raising of the light source obviously helps to reduce the difficulty experienced in that respect. If you consider the Specification spacing-height ratios and the stipulated mounting heights, you will find that in the lower grades of illumination, from E to H, as indicated in the Specification, the useful angle of light is at 80° from the vertical. (Perhaps I should say that some people speak of 10° or 15° below the horizontal, but some of us invert that and call it 75° or 80° from the vertical; please understand that they mean the same thing.) The fact that we do not get the greatest value from an incandescent burner at that angle of 80° has indicated the necessity or advisability of directional lighting.

Holophane Reflectors.

Fortunately, during the last two or three years we have had devices which help us very considerably in the distribution of the light from inverted burners. Some two or three years ago, realizing the difficulty we were in, I asked the Holophane Company to try to devise something useful for gas street lighting, and they succeeded in producing a device which is now used considerably. Mr. Copp has said that some years ago they experimented with prismatic glass and then noted the great improvement that could be derived at the useful angles from a light unit. Unfortunately, at that time, I imagine, heat-resisting glass was not obtainable, and the difficulties in that respect would probably have stopped development. The present Holophane reflector, however, is capable of resisting heat, and I do not know of a single instance in which glass has been fractured as the result of heat, though I have something like six miles of lighting in which Holophane reflectors are used. The results obtainable by means of such a device are indicated in the part of the Report dealing with directional lighting.

Happily, we have also another form of correction device which is achieving gratifying and great results, in the reflectors which are made by a well known firm in London; again we have indications in the Report of the great improvement in the distribution of light obtained at the angle of 80° (the useful angle) by means of reflectors.

Using Otherwise Waste Flux.

I am in a position to make some reference to actual figures which have been obtained, additional to those given in the Report. They all indicate to what extent there has been waste of useful flux of light from an ordinary gas burner. As we know, a good deal of light has been lost—the light above the horizontal and in the region of the horizontal, which is not of very much use for street lighting, and the light shed sideways on to the house walls; though some part of this latter is wanted there—some portion of it could usefully be re-directed. For the purpose of the International Illumination Commission's meetings at Cambridge, Mr. Auchterlonie made some great improvements in his street lighting and gave a very good demonstration of what reflectors can do. I was hoping that he would have been present at this meeting and would have given the results of the tests made at Cambridge, but he has been good enough to give me permission to use any of the information he obtained. He had different types of lanterns fitted with reflectors—lanterns of the "Rochester" type, the suspended lantern type, and the square pattern. In the case of four lamps, each fitted with four burners in a line, with bijou mantles and "V"-shaped "Staybrite" steel reflectors, at an angle of 80° the candle-power was increased from the normal of 240 or 250 to 686 candles. (These tests were made by a well-known firm who have no interest either in Holophane or other reflectors, and can be regarded as absolultely impartial.)

Of course, there is also an increase of illumination, though not perhaps to the same extent, right from the column to the mid-way point between it and the adjacent column. So that by the use of such devices one is not reducing the illumination at any portion of the area between column and column, but is simply utilizing what would otherwise be wasted light flux and thereby increasing the mid-span illumination and reducing the dark spots which, unfortunately, in the lower grades of illumination, are very noticeable. With such lighting as I have mentioned, and with the Specification spacing of 148 ft. and height of 13 ft., which is the Specification minimum—a ratio of just under 12/1—the mid-span illumination rose from 0·014 foot-candles (Class H) to 0·04 (nearly Class F). That is a very good indication of what can be achieved by directional lighting. Devices of this sort give us very great opportunities for improving our street lighting, even if we are unable to spend money on re-spacing and increasing the light units themselves.

Re-Direction of Light Rays.

Further developments have recently taken place which provide, not for utilization of the light rays on the horizontal line and above it, but for the better utilization of those that fall at an angle of 40° or 50°. I do not think there is any objection to my mentioning devices such as the "Multi-Ray" or "Morlite," by means of which one can re-direct a good deal of the light which falls at 40° or 50° to the mid-span point at an angle of 80°. I mention this matter in order to show the possibilities for gas lighting. I have been trying the addition of a "Multi-Ray" or "Morlite" reflector to an ordinarily fitted lamp. Whereas with a Holophane reflector alone I obtained a 300 p.ct. increase in the light at an angle of 80°, this increase rose to between 400 and 450 p.ct. when this other device was added, though it was not well fitted. That is a noticeable achievement. The use of the two devices rather crowded the lamp and might present difficulties to the lamp-lighter, who may perhaps upset the setting, but, at the same time, results such as this do suggest that we can effectively increase our street lighting even if we are concerned with considerations of cost.

I think Mr. Copp will agree with me that the Committee will be glad to have any suggestions which may be useful to them in their further consideration of street lighting by gas.

The Chairman: We are very much obliged to Mr. Watson for his remarks. We know that he has this matter of street lighting very much at heart, and we are grateful to him for all the work he has done in connection with it.

Mr. F. C. Smith (Gas Light and Coke Company): The Committee in the 1st Report on Street Lighting has made a very timely appeal to the Industry to be more zealous in regard to street lighting. If the Industry desires not only to retain, but also to increase, the lighting load, the importance of public lighting cannot be overstated. Any loss of prestige in this field is certain to react adversely upon the lighting load in general. There can be little question that gas for public lighting can satisfy any requirement as effectively, and in most cases more economically, than any other form of energy, but, as the report so clearly points out the strength of this position is prejudiced if obsolete burners and poor maintenance continue to exist.

Existing Installations.

As the report points out, it is often possible to effect great improvement in the lighting of a thoroughfare at relatively small cost by replacing obsolete burners, and in cases where the existing height spacing allows to improve matters substantially by the judicious use of directional reflectors. It is a commonplace, but perhaps it is worth saying, that this type of directional fitting adopted and the angle at which the fitting is arranged should be a matter of careful consideration in order that the resulting distribution of the flux of light shall be the best for the existing height spacing ratio if cost and other considerations make it impossible or undesirable to change this ratio.

Planning New Installations.

I think it will be agreed that new installations should be planned on more scientific lines than some appear to have been in the past. The Public Lighting Engineer would be well advised to construct an isolux diagram for the proposed installation. If a polar distribution curve is available for the unit to be used, and a given height spacing ratio is considered, it is possible to predict with reasonable accuracy the resulting illumination on the road surface.

For the period of the visit of the International Illumination Congress to London last September, the Gas Light and Coke Company modified the lighting of Whitehall so that it conformed to Class A requirements of the B.E.S.A. Specification. An isolux diagram was constructed before the work was put in hand. This diagram indicated that the mean test point illumination should be approximately 4·0 foot-candles. When the installation was completed actual measurement indicated the mean test point illumination to be 3·9 foot-candles. This is an example of the accuracy with which results can be anticipated, and I venture to suggest that the making of such diagrams should inspire the confidence of the municipal engineer in the competence of the gas undertaking to carry out the proposed work satisfactorily.

I should like to urge the frequent use of some form of portable photometer as a means not only of ascertaining if a new installation is conforming to requirements, but

of ensuring that existing installations are being kept in first-class condition. The Gas Light and Coke Company make a number of such tests each week, and our experience shows the effort to be well worth while.

Directional Reflectors.

I have already suggested that careful selection of directional reflectors is desirable. The electrical industry have had considerable experience in this connection, and I know that certain types of these reflectors are disliked by competent authorities in this Industry on account of the glare associated with their use. I think we can well profit by their experience in this connection.

Reference to the B.E.S.A. Street Lighting Specification will indicate that a contractor's obligation is considered as fulfilled if the service illumination does not fall below 50 p.ct. of the rated illumination. It has been urged by some that the terms Rated and Service Illumination should be eliminated, and that the contractor should be asked to tender for a given illumination. It is considered by some that the contractor should be able to assess the likely depreciation factor and make due allowance for this, and that this allowance should be adequate to ensure the provision of the illumination for which he tendered.

It may be of interest to examine the conditions which influence the depreciation factor. In the electrical industry it is extremely difficult to control variations in the supply voltage.

It is noteworthy that a fall of 5 p.ct. in the voltage is accompanied by a loss of luminous output from a tungsten lamp of approximately 18 p.ct., whereas an increase of 5 p.ct. in the supply voltage will increase the luminous output by some 19 p.ct. Incidentally, it is well known that the life of an incandescent lamp is prejudiced if the lamp is continually worked at an over voltage. The specification states that under service conditions the voltage shall be determined during the test, and if in excess of the declared voltage a suitable correction shall be made.

In the case of a gas unit, a 5 p.ct. variation in the supply pressure will have but small effect upon the luminous output. Moreover, pressure variations can be almost entirely eliminated by providing a pressure governor.

It would seem, therefore, that from consideration of pressure variation, it is necessary to allow for a higher depreciation (*i.e.*, difference between service and rated value) in the case of electric lamps than is necessary for gas burners.

Variations in the size and quality of incandescent mantles will affect the luminous output from a given burner. It is suggested that all samples of mantles purchased should be gauged for size and tested for lighting efficiency as well as strength.

By far the greater factor, however, influencing luminous output is the quality of the general maintenance work. In general, provided a mantle is undamaged, the full lighting value of the burner can be restored by removing the mantle, cleaning the burner, and replacing the mantle. Reflectors and glassware should, of course, have adequate attention. In the case of an incandescent lamp it is necessary to replace these by new ones every so often, if the lighting efficiency is to be maintained, and this is a costly business. Experience over a number of years has shown that in the case of high-pressure lamps under good maintenance, a depreciation factor of from 25 to 30 p.ct. is an ample allowance. For low-pressure lamps under good maintenance a lower depreciation factor than 25 p.ct. can probably be secured. The Gas Industry does not require a 50 p.ct. depreciation clause in a lighting specification.

Fog Penetration.

May I say I am a little sceptical of the claims made in the report in regard to fog penetration, although I am aware that it is commonly held to be true by many people outside the Industry, whose experience is certainly worthy of consideration. I think we should be on safer ground in regard to this claim if it were supported by more direct scientific evidence.

It must be agreed that reliability is a great factor in favour of gas for street lighting, and it is a factor which has had considerable weight with some municipal authorities in the past.

Data.

In the Report, reference has been made to the B.E.S.A. Specification for tungsten filament lamps. This Specification gives the lighting engineer reliable data in regard to the performance to be expected from these lamps. I feel that the Gas Engineer is at a disadvantage in this respect. At present he has to rely very largely upon the data supplied by manufacturers of lamps, and, although the makers are to be commended for supplying this information, it is sometimes rather incomplete, and cannot in the nature of the case command such respect as an authoritative statement by a competent disinterested body.

In regard to the B.E.S.A. Street Lighting Specification, this is not the time to enter into a discussion as to the merits of this Specification. A street lighting specification is a very difficult thing to draft, and those who were present at the International Illumination Congress in Cambridge will remember the differences of opinion which existed between the secretariats of the various countries as to what should be included in a Street Lighting Specification. Some feel that the fixing of the test point on a geometrical basis is unsound. There is little in this Specification to guide the lighting authority as to the class of installation he should ask contractors to tender for. It has been suggested that the speed and the volume of traffic passing along any thoroughfare should be some index as to the amount of illumination it is necessary to provide. Perhaps the Industry can offer some constructive suggestion in regard to this matter.

Mounting Heights.

Capt. W. J. Liberty (late Public Lighting Superintendent of the City of London): There is one particularly bright spot among the many in this Report—viz., in the last paragraph dealing with the height of light sources. If the Report has done nothing else than to draw attention to the mounting heights of lamps and getting them raised, it has justified its existence. When I lighted the City of London nearly half a century ago my mounting heights were all about 11 ft. or 11 ft. 6 in., with the exception of a few special refuge lamps containing large multiple flat-flame burners, consuming about 50 c.ft. of gas per hour. This height of 11 ft. was general throughout the country, and has up till quite recently continued so. The additional height of 3 ft. 6 in. with modern and additional burners makes all the difference in the illumination of the thoroughfare, with a better dispersion of light on the roadway and the light taken out of the eyes of the motorist. I do appeal to engineers and managers having charge of the public lighting in their areas to increase their mounting heights by fitting on the extension pieces to their columns. They are inexpensive and there is nothing to scrap. Providing they attend to their burners at the same time, they are going to improve the public lighting greatly. I would ask you not to take too seriously the statement in the Report: "It is recognized that improvements are being effected by various gas undertakings, but these, unfortunately, are not general." There are many well illuminated areas in large centres, chiefly in London and the Municipal Boroughs in the outer ring of the Metropolitan area—viz., Lambeth, Camberwell, Deptford, Lewisham, Bayswater, Chelsea, and Tottenham—where good main road lighting has recently been carried out, which, with centrally suspended high-power lamps, properly spaced and at the correct height, bring comfort to the pedestrian and safety to the motorist.

A General Advance.

There has been a general advance in public lighting practice these last two or three years—viz., in the numerous references to public lighting in the ordinary Press, gradual addition to the number of public lighting departments under special officials, gradual increase in the numbers of lighting departments issuing annual reports, general increase in the number of public lamps, lighting of villages, districts, and roads hitherto unlighted, lighting for greater number of hours per annum, and by extending the hours before sunrise and "lighting up" earlier before sunset, thus gradually approximating nearer to 4300 hours per annum. Then there have been the lighting of new housing estates and arterial roads, improvement of illumination in streets previously lighted, including side streets often neglected, and special attention to town centres, busy or dangerous junctions, and marine parades. Closer spacing of lamps in new streets than the former custom has been observed, also of those in installations that have been altered. Then consider the displacement of older types of lanterns by modern or more efficient types, erection of public lamps more in harmony with surroundings or more deliberately ornamental. There have been a noticeable increase in the number of mantles per lamp, adoption of horizontal or roof burners in square lanterns with mantles in alignment, adoption of "high power" low-pressure lamps with several mantles in clusters in round globes or all in line, resulting in a general increase in consumption of gas for public lighting. There has been an increase in the use of directive lighting in which the lighting is more or less concentrated along or across the thoroughfare. There has been the use of reflectors of various shapes of silver glass or bright stainless metal, and also refractors of various types. Most noticeable is the increase in the mounting heights, in particular, adoption of the minimum height of the British Specification, 13 ft. and 18 ft. and higher with lamps having four mantles or more. Tall steel or concrete poles have been erected in preference to cast iron, and there has been the continued extension of

automatic control of lamps, mostly by clockwork. Then there has been the shortening of the period of reduced or "summer" lighting, for it can hardly be conceived in these days of grace that there are towns of considerable size and villages through which main roads pass which are wholly without public lighting during the months of June, July, and August. There has also been a marked increase in traffic signs and the erection of special warning lamps on refuges and islands in cities and large towns.

Need for Lighting Engineers.

All these improvements count for the good, but we must have lighting engineers or superintendents especially appointed to deal with the question of public lighting. At present the public lighting is in the hands of the City Engineer, Borough Engineer, Borough Surveyor, surveyors to Urban or Rural Councils, the gas engineer and manager or the electrical engineer and manager. You could count on the fingers of both hands the number of public lighting engineers or superintendents who have the sole control of public lighting and have direct access to the watching or lighting committee. In addition to the foregoing list of officials, I have compiled a still further list of those who deal with public lighting as a kind of side show to their ordinary job. These are not imaginary titles, but are obtained from a questionnaire I sent out this autumn, the replies of which are signed by the various town clerks. I give a further sample, "Chief constable," as if this official had not sufficient to do with traffic in these days of mechanically propelled fast traffic, motor bandits, and the withdrawal of the speed limit. Next on the list is "fire master," then follow "inspector of cleansing," "gas meter inspector," "gas examiner," "mains superintendent," "inspector of subways," "market superintendent," "inspector of overhead wires," and last, and most illuminating, "foreman scavenger." After this, can one wonder at the remarks of Councillor Minshel (Chairman of the Sheffield Lighting Committee) at the Edinburgh Congress as to the public lighting official being a sort of "glorified lamplighter"? Even where the lighting superintendent is an independent official in some of our largest cities, he is also the cleansing inspector or the gas meter inspector, which must give only a limited time to the lighting section of his duties. Where the duty devolves on the borough engineer, or surveyor, his hands are so full with road construction, re-paving, new housing estates, &c., that he has to delegate the duty of public lighting to a junior in his department who has neither the experience nor the scientific knowledge to deal with the matter efficiently.

From these remarks it will be seen that there is abundant work before the Institution Lighting Committee as well as such matters as road surface reflection, &c. The Committee can do good work in the future.

The Question of Costs.

Mr. J. W. Lofts (Wm. Sugg & Co., Ltd.): As a member of the Street Lighting Committee, I am very pleased to be present this morning. We have had put before us the scientific formulæ, we have been given a very long list of the various people who are in charge of public lighting, but we want to get down to the actual facts in regard to costs. Both Mr. Copp and Mr. Bloor have studied very closely the problem of the price of gas for public lighting, but during this last week I came across a quotation which I think you ought to know of. A certain electricity department or authority, under Government control, is quoting £3 1s. per year for each 100-watt lamp fitted with a bi-multi reflector, for a year of 3730 hours. A 100-watt lamp will give an illumination of 100 candles without the aid of a reflector, and it is necessary to put against that a 4-light bijou cluster burning 6 c.ft. of 500 B.Th.U. gas per hour, again leaving out of account the use of a reflector. Assuming 4000 hours' consumption per annum by such a cluster—the 270 hours, which is the difference between 3730 and 4000, representing the by-pass consumption—it will consume 24,000 c.ft. of gas per annum, and, at a price of 1s. 6d. per 1000 c.ft., the total cost of gas will be £1 16s. During the year about 12 mantles will be required, representing a cost of 4s., so that the cost of gas and mantles will be £2. Assuming the cost of cleaning the lamp is 3d. per week—it may be more in some places—that adds another 13s. for the year, increasing the total figure to £2 13s. The difference between that and the £3 1s. is 8s., and that is the amount left for maintenance of panes, reflectors, and so on.

Mounting Heights.

With regard to mounting heights in the case concerned, where electricity is competing with gas, the gas lamps have been mounted on 9 ft. columns, and the electricity authority is installing lamps at heights up to 14 ft. 9 in. That is evidence of the increased mounting height enjoyed by the electrical people as against the gas people. We know by reference to the table that the mean spherical candle-power of the 100-watt lamp is 100 candles. So we have to effect a reduction in the price of gas where we have to face this electrical competition. That is the first and foremost question. What proposals can we make against the 100-watt lamp equipped with a bi-multi reflector at a charge of £3 1s. per annum for current and maintenance? The lamp will consume, on the average, 400 units per annum, and, at 1d. per unit, that will cost £1 13s. 4d. The average life of a bulb is 1000 hours; assuming, therefore, that 4 bulbs will be required per annum, at a cost of (say) 10s., we arrive at a total figure of £2 3s. 4d. The difference between that and the £3 1s. is 17s. 8d., which is left for maintenance—and they have merely to send a man round from time to time to wipe over the bulb and the reflector.

Advertising Value of Street Lighting.

Mr. W. T. Dunn (late Secretary of the Institution): I can see the hand of Mr. Watson reflected in this Report, and I consider that the Research Committee of the Institution did one of the wisest things they have done lately in appointing this Street Lighting Committee and in giving Mr. Watson an opportunity of doing more work in a department which I know he loves. Mr. Watson and I had the honour of representing the Institution on the International Illumination Commission at Geneva, and, naturally, we did all we could to uphold the claims of gas. But you all know as well as I do that for some years it has been most difficult to get the gas people to take an interest in these things; our electrical friends are very deeply concerned with them, and fully appreciate that it is in their interest to be represented on such bodies.

I have been impressed, as we all must be impressed, by the importance of the co-operation of manufacturers in the solution of our problems in connection with lighting. Gas engineers have many things to do, and their duties appear to be multiplying; we must look to those who supply the apparatus to help us to deal with the problems that present themselves. At Manchester, not many years ago, we were told by a very prominent engineer that the days of gas lighting had passed, and he urged us to concentrate on the application of gas to heating, industrial processes, and so on. It is a very good thing that we did not accept that view. To-day we have some very good examples of gas lighting in many towns, particularly in London and in some of the seaside resorts. The public, when they see these installations, are made to realize that gas lighting is very good, and their thoughts are directed to the value of gas in their own homes; so that public lighting by gas is of the greatest possible importance as an agent of propaganda for the Gas Industry. Gas engineers should do all they possibly can to extend street lighting by gas, because of its great advertising value. In respect of reliability we have a great pull over electric lighting, and that is an element in gas lighting which should never be forgotten. We have known many cases in which the electricity supply has failed at the wrong moment, and very serious consequences have ensued. I cannot help referring to one feature of the public lighting of the town in which I live. Why do the lighting authorities send men round with long poles regularly to light the lamps and again to extinguish them? I should like to know whether that is still done in other places, for it does appear to be antiquated. It may be done, of course, with a view to assisting employment!

Another matter to which I think we should pay more attention is that of making direct comparisons between the prices of gas and electricity. We must not forget that in comparisons of the prices of gas and electricity on the basis of heat value the advantage often goes to gas; in my own town the authorities advertise the price of gas per unit as compared with the price of electricity per unit, and the figures have opened the eyes of the public. They cannot understand why the price of a therm seems to be so very great, but when they see the prices of the two commodities related they appreciate that gas has the advantage.

Glare.

Mr. L. T. Minchin (Gas Light and Coke Company): One of the speakers has raised the question of an electric lamp fitted with some such reflector as the "bi-multi," and I think that much of the severe competition which the Gas Industry is encountering can be traced to the assumption that because one of these reflectors is fitted to a 100-watt lamp and a maximum beam candle power of 600 is obtained, it is therefore equivalent to a 600 c.p. lamp without any reflector. This is demonstrably untrue. First because the beam is quite narrow and may only refer to one half of the road, and secondly because there is a big increase in visibility glare when these fittings are used.

It must be remembered that the final consideration of street lighting is not foot-candles obtained, but in visibility, and visibility may be greatly impaired by the use of

glaring light sources. The work of the National Physical Laboratory has enabled the glare of any installation to be calculated, and we have applied this method to the new Whitehall installation and found it to be about 5, which is within the limit suggested by Dr. Stiles, although this figure is higher than usual for a gas installation. It should, however, be realized that this figure of 5 represents a depreciation to one-fifth of the visibility which would be obtained if no lights were visible in the field of view at all. With such fittings as those mentioned above, where the candlepower at angles near the horizontal has been greatly increased by the use of reflectors, this figure may be as high as 10; and it is clear that much of the advantage obtained from this extreme directional reflection is offset by the diminution in visibility resulting from the glare. This effect can be readily realized if the following simple experiment is performed in a street at night.

The road is first observed and some detail just discernible is picked out. The eyes are then shaded from the actual lights in the street, and it will be noticed that the details become much more clearly discernible. I suggest that a B.E.S.A. Specification should be framed to prohibit the use of fittings which result in a very high candlepower at angles near the horizontal, and which result in an increase in illumination as measured by the photometer, without the corresponding increase in visibility which might be expected.

Mr. Watson's Reply.

Mr. Watson, replying to the discussion, said: I think the members of the Street Lighting Committee who are present will have appreciated the very kind interest which speakers have taken in the Report and the suggestions they have made. Mr. Smith's contribution was exceedingly useful, and the points made in it will, of course, be borne in mind. Both Mr. Smith and Mr. Minchin have alluded to glare, and I should like to refer to that matter. First of all, gas lighting does not present any great difficulty in respect of glare. It is true that in certain forms of directive lighting there is a slight increase of glare, but it is not serious. From a low-pressure burner, from which the light is not directed by any adventitious aid, the known intrinsic brilliancy is 50 c.p. per sq. in., which, compared with the intrinsic brilliancy of the light sources of our competitors, is very low; and I do not think that glare can be high in that case. With directive lighting there is a tendency towards more glare, but I fail to see that it can be called "objectionable"—the expression used in the Specification. If there is glare, it can always be minimized by increasing the height of the light sources, as was the intention of the Specification. The greater the height, the better. I remember one case in which, by reason of the existence of a raised footpath, I had to place a lamp, fitted with a Holophane reflector, at a height of 22 ft. from the ground. In this case I obtained extraordinarily good distribution of light, and failed to notice any glare at any place from the column to the mid-span point. That indicates very well that by increasing the height of lamps we can practically eliminate the glare difficulty.

It was not the intention of the Street Lighting Committee, in submitting this Report, to raise a discussion on the relative merits of gas and electricity, and I hope you will excuse me if I do not touch on the electrical aspects of the problem. We want to ensure that every effort is made to improve gas lighting for street lighting purposes, and our purpose is to endeavour to suggest means. I was rather surprised to hear some of Mr. Lofts' figures, and I hope that those relating to gas lighting were on the high side. He referred to the use of 12 mantles in a lamp per annum; I think that if he had assumed one-third or one-half that number it would have been sufficient.

Mr. Lofts: I was referring to a 4-light lamp, which means 3 mantles per burner per annum.

Mr. Watson: My figure is lower than that, but, anyhow, I will accept yours. With regard to fog penetration, I have hope that Watson House will obtain scientific proof that gas light has a better penetrating power in a fog or a mist than has electric light. Unfortunately, I understand, such evidence is not yet complete. The Street Lighting Committee's report simply suggests that one can demonstrate the advantage of gas lighting over electric lighting for fog penetration by observation, and I had a very good example of that a week or two ago in one of our districts, where a housing site was illuminated by electric lamps of equal candle-power to our own gas lamps, and where the spacing between lamps was less than that between the gas lamps. This housing site adjoined an area illuminated by gas. On the night in question the fog was so thick that it was very difficult indeed to ascertain exactly where one was, and I was very much impressed by the fact that, whereas, in the electrically illuminated area, when I stood at one lamp-post I could not see the next lamp, in the gas illuminated area, where the lamps were spaced farther apart, there was never a time when I could not see from one lamp-post just a suggestion of the lamp on the next post.

Finally, I should like to direct attention to the fact that at the end of the Street Lighting Committee's Report there is a bibliography of the books to which those interested in public lighting can refer. I would suggest also that a careful study of the papers presented at the Edinburgh Congress of the International Illumination Commission is well worth while, because those papers contain particulars of a large number of typical gas lighting installations, and full data are given.

Comparative Costs at Hull.

Mr. Copp: I do want to express my thanks to Mr. Watson for having made good my delinquencies in introducing this Report. With regard to the measurement of light, I have adopted the method of dividing the road into 10-ft. squares and determining the illuminating power falling on each of those squares; that, I think, is a method which cannot be criticized, because it shows the light given at each point. I think that one of the great pieces of work done by the British Engineering Standards Association Committee is the classification of lighting standards from Class A to Class H. If one is discussing street lighting with a local authority, one can find out what class of illumination is required, and one knows precisely how it can be obtained.

I think Mr. Lofts regretted that I did not give more information as to the costs of the gas lighting at Hull to which I have referred. The smallest light we shall offer to the Corporation will give 277 c.p., it will consume 6 c.ft. per hour, the minimum illumination at the test point is 0·025 c.p. (which is well within Class G), and the cost quoted is £3 19s. per annum. That compares with £4 4s. per annum, I think, quoted for a 100-watt electric lamp. I do not know how the electrical people make up their costs, or how much it costs to maintain the lamps, but I feel pretty certain that the maintenance of those lamps will cost a lot more than the maintenance of our gas lamps, because I notice that the electrical people have their extending ladders at work often. I remember that in the Potteries, about 1915, my Company put up a large number of lamps at their own expense—nearly 1000, I think—and at that time I used superheated cluster burners. A lot of my friends asked what I was thinking about, and said that I was putting three mantles in a lamp though I could not maintain one. Well, we have come now to the use of the smaller sizes of mantles; we know that the maintenance costs are very much lower and that the efficiency is very much higher, and we have satisfied ourselves recently that the proper, the best, and the most efficient burner for street lighting is the one with the mantles in alignment, because it lends itself so very much better to the use of reflectors.

With regard to the difficulty of height, I would point out that a lot can be done by extending the height of the existing lamp-posts. I think that our lamp-post extensions, which are about 3 ft. 6 in., cost only about 4s. 6d., so that a great deal can be done at very little expense to improve the lighting. I do suggest also that anyone responsible for any kind of lighting, whether by gas or electricity, but particularly gas, should possess a suitable portable photometer. I cannot emphasize that sufficiently; unless you have such an instrument you cannot talk with certainty of the efficiency of the lighting you are dealing with.

Influence of Inorganic Constituents on Carbonization

Gas Research Fellowship Report

Submitted by Prof. J. W. COBB and Dr. A. H. EASTWOOD (Research Fellow)

Dr. S. PEXTON: In this report, Prof. Cobb and Dr. Eastwood have shown that the increased ammonia yield when carbonizing coal mixed with lime is due to the decomposition of gaseous products by the lime and not to the interaction of lime with the nitrogen compounds of the coal. It is also shown that when low-temperature coke is heated, in stages of 100°, from 500° to 1000° C., there is a remarkable parallelism between the rates of ammonia evolution and gas evolution; in other words, that both are formed from complex organic nitrogen residues in the low-temperature coke.

Thus, it may be said that Prof. Cobb and his assistants are making use of the presence of ammonia in coal gas to study the changes which take place when coal is heated. This method is often employed in practice to indicate the conditions met with in particular carbonizing installations. For example, the yields of ammonia from some of our installations of large vertical retorts are low, being of the order of only 25 gallons of 10-oz. liquor per ton of coal, compared with from 30 to 35 gallons of 10-oz. liquor from our horizontal retorts and smaller vertical retorts. The conclusion to be drawn is that in these particular retorts there is rather more degradation of ammonia, and consequently of hydrocarbons, taking place. This is also indicated by the reduced yield of tar and the increased yields of organic sulphur compounds, and also by the reduced yield of rich unsaturated hydrocarbons in the gases. This has the ultimate effect that the calorific value of the coal gas, as distinct from the mixed gas, is much lower than in the smaller retort installations, and it restricts seriously the amount of water gas which may be added to reduce the calorific value of the mixed gas to the desired standard—*i.e.*, by additional steaming.

It is sometimes imagined that a carbonizing plant which produces no ammonia would be a boon to the Gas Industry. I think, however, that from these illustrations it is clear that, if such a plant were invented, it would produce such a low-grade gas that it would be of interest only to very few undertakings.

I should like to thank Prof. Cobb and his assistants for the patient manner in which they are carrying out this work. If they can make use of the presence of ammonia in coal gas to elucidate some of the complexities of carbonizing reactions, I think it will be some compensation to those who are struggling to dispose of ammonia from an industrial point of view.

Prof. COBB: I mentioned to Mr. Alexander, in correspondence, that I did not expect this Report to give rise to any lengthy discussion; that has been borne out. The remarks of Dr. Pexton about the general effect and the possible parallelism between ammonia production and other phenomena in carbonization, and the possibility of using that parallelism for purposes of deduction, were very interesting. I think the whole question of the effect of surfaces such as those of the lime plugs we used in our experiments on the products of carbonization is one that is worthy of much more extensive study. It so happens that in this case it has been studied with special reference to ammonia, for obvious reasons, but I think there may be quite important phenomena that deserve further study in connection not so much with ammonia as with tar and gas. Our information on that subject requires extending in a number of directions; one of those directions, I think, will be made plain in the report to be presented later with reference to the cracking of creosote.

The PRESIDENT: Although there has not been much discussion on this Report, it describes some very interesting work, and it will repay careful study.

Creosote—Its Use as an Enriching Agent and its Market Potentialities

29th Report of the Joint Research Committee

Research Chemist: Dr. F. J. DENT

Mr. W. B. REIDIE (Bromley Station of the Gas Light and Coke Company): The purpose of these notes is to describe preliminary trials of the gasification of creosote oil, and since the process is closely related to that employed in earlier tests for the gasification of heavy fuel oil in carburetted water gas plants, some remarks concerning these earlier tests are included in the belief that they will be of interest.

In order to determine the value of heavy fuel oil in the manufacture of carburetted water gas under English conditions, it was decided to equip with the necessary apparatus one of our automatically operated (Humphreys & Glasgow) self-clinkering generator sets. The modifications were as follows:

(1) An oil spraying device was fitted to the generator and arranged so that oil could be sprayed on the top of the fuel bed.
(2) A duct was fitted round the shell of the generator in such a position that blast air could be delivered to the upper part of the generator through a number of nostril blocks inserted in the upper firebrick lining.
(3) Existing oil storage tanks were fitted with primary heating by means of exhaust steam.
(4) A high-pressure oil pumping unit.
(5) A secondary oil heater of the tubular type.
(6) A high-pressure oil meter, together with the necessary valves and cocks.

During the early stages some difficulty was experienced in maintaining the top of the fuel bed at a temperature sufficiently high to prevent undue absorption of oil by the coke. Subsequent adjustments overcame these difficulties and trial runs over a lengthy period were successfully carried out. The operation proved to be almost as smooth and flexible as when using gas oil. The data obtained during the period of operation showed that, while the enriching value of heavy fuel oil was slightly lower than was regularly obtained from gas oil, the carbon from the oil deposited in the fuel bed effected a considerable saving of coke per 1000 c.ft. of gas made.

GASIFICATION OF CREOSOTE OIL. EXPERIMENT "A."

For the experiment we received from our Products Works a consignment of approximately 50,000 gallons coal tar creosote free from crystallizable naphthalene and containing no "still bottoms," the specific gravity of which was 0·992 at 60° Fahr.

No alterations were made to the equipment installed for the heavy fuel oil trials, but since the viscosity of the creosote was low by comparison with heavy fuel oil it was not necessary to employ the secondary heater.

The first portion of the trial was restricted to the spraying of creosote oil into the generator during the up-run only, blue gas being made during the back-run, as in normal carburetted water gas practice. The quantity of creosote oil admitted to the generator was gradually increased up to 2·5 gallons per 1000 c.ft. of carburetted water gas, although at this rate there was some considerable

falling off in thermal yield, owing to the excessive cooling effect on the top of the fuel bed. A yield of 0·75 therm per gallon was obtained when using creosote oil at the rate of 1·03 gallons per 1000 c.ft. No accurate coke measurement could be obtained during this part of the trial, but it is estimated that by comparison with normal operation, using gas oil, a saving of approximately 2 lbs. of coke per 1000 c.ft. was effected.

The gas yield per gallon of creosote oil varied considerably during the tests, but for the purpose of calculating thermal results an average value of 30 c.ft. per gallon was taken.

No trouble with heavy deposits in the condensers was experienced, but it appears from analyses that over a prolonged period of operation special precautions might be found necessary since the tar would solidfy on cooling. Tests of the gas at the outlet of the tar extractors showed that the average naphthalene content was approximately the same as that obtaining with the use of gas oil.

Had we been able to continue the experiments it is believed that even higher yields could have been obtained.

Experiment "B."

A second trial run was carried out in order to determine the thermal yield obtainable from the same oil (creosote) when admitting during the back-run period only. In this process the hydrocarbon content of the creosote oil is broken down during its passage through the hot fuel bed, hydrogen being liberated and the separated carbon deposited in the fuel bed.

Following a short trial run in order to make the necessary adjustments in the operating routine, two separate tests were carried out. The quantities of creosote used were 0·99 and 1·36 gallons per 1000 c.ft. respectively. The former or lower gallonage gave the best result—viz., 0·73 therms per gallon, compared with 0·75 therms on the up-run experiment. In addition, there was a saving of approximately 6 lbs. of coke per 1000 c.ft. of gas made.

The naphthalene content of the gas at the outlet of tar extractor was 2·5 grains per 100 c.ft.

Although when using creosote oil alone the calorific value of the final gas was only about 330 B.Th.U. per c.ft., the method described will permit of gas oil being used within limits in the carburettor during the up-run just as in normal carburetted water gas practice, thus affording the opportunity of further enrichment. But for the fact that we were called upon to put another setting to work, that experiment would have been carried out, and I have the permission of the Chief Engineer to say that, as soon as output will permit, we will return to that experiment.

The main object of these experiments was to determine whether or not creosote or other heavy oils could be successfully gasified in our carburetted water gas plants. Our experience has shown that it can be done without, in my view, any very serious trouble.

Creosote Unattractive as an Enriching Agent.

Mr. H. Hollings (Gas Light and Coke Company): The results which have been placed before us by Dr. Dent are in general agreement with the results obtained by the Gas Light and Coke Company, when creosote was used on full-sized units of water gas plant with or without the special modification described by Mr. Reidie. It may be noted also that none of the later experiments conflict in any material respect with the earlier laboratory investigation at Fulham, which was noted by Dr. Dent in his first report upon this subject. Broadly speaking, therefore, we are forced to the conclusion that, when creosote is used for enriching water gas, it is worth just about one-half as much as gas oil. Now if we are to believe the considered statements which have been made within recent months by responsible authorities connected with the petroleum industry, it is clear that, in the absence of any national emergency or a substantial import duty, the price of gas oil must remain so low that the value of creosote as an enriching agent will remain very unattractive for some time to come.

The real value of the work which has been done is to demonstrate a practical method of disposal of surplus creosote in case of necessity. Probably the generator of a water gas plant with the modifications described by Mr. Reidie offers a convenient means of disposal of any carbonaceous material provided that the material can be introduced to the top of the coke bed during the back-run. We should not, however, be content to look upon creosote as a refuse to be disposed of in this way. There are at least three alternative methods of marketing creosote which I think should be kept clearly in mind by this Institution.

Three Methods of Marketing Creosote.

First of all advantage should be taken of the extending use of Diesel engines for a wide variety of purposes. Much work is being done both in connection with large units such as may be found in electrical generating stations and small units being developed for road transport purposes. Here is a field in which a home-produced oil can be used with a greater thermal efficiency than can be imported petrol in a spark ignition engine, and the potential market is open to every tar distiller.

The peculiar properties of creosote render it perhaps more suitable for use in the spark ignition engine provided that there is a proper degree of pre-heating of the creosote entering the cylinder. It is necessary, of course, to arrange for some other fuel for starting up the engine and for use when idling. In this connection considerable advances have been made in the development of a duel carburettor which permits of the use of either ordinary motor spirit or a heavier fuel such as creosote. Work along these lines, as you know, has been proceeding in London, Belfast, and other centres. So long as we attempt to substitute creosote for a petroleum oil in any cracking process, we have to admit the inherent inferiority of creosote due to its aromatic nature; but in the internal combustion engine of the spark ignition type creosote possesses a very definite advantage over petroleum oil in its anti-knock properties, and it would appear that there is room for more investigators in this field to give consideration to the various problems associated with engines of high compression ratio used in conjunction with creosote of different qualities.

Finally, I should like to refer to a third line of development—namely, the possibility of hydrogenating creosote.

Hydrogenation.

We have all heard a great deal during the past few months upon the subject of hydrogenating coal, and there has been such emphasis upon the coal that there is some danger that sight may be lost of the fact that tar oils are much easier to hydrogenate than coal. First of all there is the mechanical advantage of handling a liquid rather than a paste of coal and tar at the very high pressures involved. Then, considering that hydrogen is such an important factor in the cost of the process, it is important to bear in mind that a tar oil such as creosote requires only one-half as much hydrogen as does coal. This is a subject which ought to receive most serious consideration by the Gas Industry. We possess the most suitable indigenous raw material which exists in quantity to-day. We also have the potential sources of hydrogen, and we can use the methane and other rich gases which are a bye-product from the process as a substitute for gas oil in the enrichment of water gas.

We have been investigating the hydrogenation of tar for some time, and in the Fulham laboratory we have produced motor spirit from creosote. It may be of interest if I give a very brief outline of the results obtained and show you a few samples. Here is the raw material; and when this is treated with hydrogen under a pressure of about 200 atmospheres at a temperature of about 440° C., we obtain this liquid product. The yield is just about 100 p.ct. by volume, but, as you would expect from the appearance, there is a decrease in the specific gravity and a consequent loss upon a weight basis. That small loss is accounted for by the formation of water equivalent to the oxygen in the creosote and by the formation of hydrocarbon gases such as methane.

Now when this crude product is submitted to a simple distillation process it gives us 56 p.ct. of spirit boiling below 180° C. This spirit is mainly aromatic; it contains about 17 p.ct. of paraffins, and its value as a motor fuel is intermediate between that of petrol and benzole. You will very properly ask what we propose to do with this distillation residue, which represents about 40 p.ct. of volume by the original creosote. There are several possibilities. It might be used in the Diesel engine or the spark ignition engine by either of the methods which I have just suggested for creosote itself. Alternatively it may be submitted to a second treatment with hydrogen either alone or mixed with fresh creosote. It then gives us a further yield of spirit amounting to about 40 p.ct. of its volume. In any case I think we might safely predict that it could be disposed of as an enriching agent for water gas by the method now being considered by this meeting.

Work at the Fuel Research Station.

Dr. J. G. King: I am afraid that Mr. Hollings has already anticipated a great deal of what I came prepared to say to-day. In view of the somewhat disappointing results which Prof. Cobb and Dr. Dent have obtained in the use of creosote oil in place of gas oil, with carburetted water gas, it seems to me that we should look in other directions. Mr. Hollings has already referred to this aspect of the matter, and another line of action is the hydrogenation of these creosote oils into substances which might have a better market. I have with me some results from experiments carried out at the Fuel Research Board Station which are somewhat similar to those given by Mr. Hollings. Using a suitable catalyst it is possible to hydro-

genate creosote oil under pressure and to get a yield of 97 p.ct. of the weight of the original creosote oil, with about 2½ p.ct. by weight of hydrogen. The crude product is very similar to the one shown by Mr. Hollings—namely, a fluid yellow oil. Of that product some 64 p.ct. is in the motor spirit range boiling below 200° C. The composition of this motor spirit differs slightly from that of Mr. Hollings' motor spirit. He finds it contains a low proportion of saturated hydrocarbons, but we find that our oil contains as much as 40 p.ct., the remainder being 6 p.ct. unsaturated hydrocarbons and 54 p.ct. of aromatic hydrocarbons. This high content of aromatics makes it an important fuel from the point of view of its high anti-knock properties; but, on the other hand, it has one slight disability. The tar acids in the creosote oil are hydrogenated largely to toluene, and the proportion of the spirit which boils below 100° C.—which is important from the point of view of starting the engine—is rather low. It is, however, possible that we may be able to get over that difficulty. The other 30 p.ct. which remains behind we are considering treating by re-processing, by re-cycling it back to the catalyst again.

Unfortunately, I have no results dealing with re-cycling, but I can tell you that we have operated a small continuous plant with an even more unpromising material than creosote oil—namely, low-temperature tar. We have been able to run this continuous plant for a week without re-charging the catalyst, and the run was terminated only because we wished to know what had happened to the catalyst. With Mr. Hollings, therefore, I consider that here is a perfectly sound outlet for creosote oil which ought to give a much higher value than would be possible by substituting for it gas oil. It is impossible at the moment to give any idea of costs, but the plant is relatively simple and the catalyst is the only problem which is really left. It is in this connection that prolonged experiments should be carried out in order to discover whether this catalyst is going to operate for a sufficiently long period of time before requiring revivification, and whether it is possible to revivify it at all.

The CHAIRMAN: We have listened to an interesting discussion and particularly to the remarks concerning hydrogenation and the use of creosote for motor transport; I think there are great possibilities in these two directions and we await further investigations with great interest.

Dr. DENT: Actually I think there is very little to which I have to reply, as most of the remarks have been a very valuable addition to the paper. Mr. Reidie seems to have an impression that his results are in contradiction to ours, but from the figures he gave us I do not quite see where the difference comes in. He spoke of a yield of ¾ therm per gallon, which I think is a yield we have already obtained in our experiments. I do not think there is a very great difference between the two sets of results. The point which I was rather surprised at was the claim for the saving in coke, and especially his last figure of 6 lbs. of coke per 1000 c.ft. of gas made. I do not think you will get any more carbon than that by the actual decomposition of the oil itself, and that does not seem to leave any heat over for the actual decomposition of the oil. That is, therefore, a rather surprising result. Mr. Hollings' remarks were extremely valuable.

Permeability of Refractory Materials to Gases and the Action of Carbon Monoxide on Refractory Materials

Twenty-Second Report of the Refractory Materials Joint Sub-Committee

Mr. FRANK WEST: I am very pleased to have this opportunity of making a few remarks on this Report on Refractories. From our association with the Refractory Research Association we are able to testify to the very excellent work that has been carried out by the investigators in connection with this problem, and that work is very well portrayed in this Report. It is evident from the reading of the Report of the work carried out by the British Refractory Research Association that two new problems of particular interest to the Gas Industry have been investigated. The problem of permeability of refractories; the action of carbon monoxide on refractory materials. There is also a further report on refractory jointing cement and hot patching of retorts. Dealing with the question of permeability of refractories, several very important points have been discovered. First, that the pore characteristics of the material have a big bearing on the question; secondly, silica bricks generally are more permeable than firebricks; thirdly, the size of the pores has a great influence on permeability (for instance, insulating material made of diatomaceous earth has a very low permeability, although it is, as you know, very porous); fourthly, it is interesting to note that the effect of "skin" on the resistance to the passage of gas is very small. Another curious suggestion is that the poorly fired bricks might resist penetration better than well-fired ones. We await with interest the future tests at higher temperatures.

ACTION OF CARBON MONOXIDE.

Dealing with the second investigation, that of the action of carbon monoxide for refractory materials, the chief points elucidated appear to be that the nature of the iron in the refractory has a great bearing on the liability to disintegrate, and it appears that longer treatment of the samples is absolutely necessary to form a correct idea on this subject. This investigation must be of great use to the Gas Industry, as it should throw some light on the behaviour of refractory materials in retort settings.

The Report on jointing cements shows, as most of us know, that the problem of choosing a satisfactory article is not an easy one. The methods advocated have definite advantages, and point out that the question of refractories alone is far from sufficient. It would, however, be very useful if the authors could show the actual behaviour of test pieces by means of percentage movement curves.

HOT PATCHING.

It now appears that the question of further experiments with hot patching has arrived at the stage where it must be tried out more in actual practice; and I have no doubt that many of the gas engineers will be ready to allow experiments to be made—in fact, I understand that several have already expressed their willingness to assist in this matter. Several experiments have been made with blowing-out or projecting cements or fine ground silica into cracks or on to eroded patches by means of compressed air. Most of these have only met with limited success. A promising recent development is a piece of apparatus in which the patching cement and the compressed air are taken to the spot in the hot retort through a water jacket. The patching cement, which is applied in quite small doses, is kept liquid in this way right up to the point of application.

I should like to mention, in conclusion, that I was very pleased to hear the remarks of the Chairman of the Research Association yesterday on the value of research, and I should certainly like to back that up and say that, in my opinion—and I believe in the opinion of many others—the results from the financial point of view of the investigations which have been carried out by the Research Association give back their value at least £ for £ in regard to what has been expended in the past; and I should like, on behalf of the Council of the B.R.R.A., to thank you for the support you have given to the Research Association in the past, and to express the hope that you will continue it in the future.

JOINTING CEMENTS.

Mr. A. EDWARDS (Gas Light and Coke Company): I would like to make a few remarks on the small section of the Report embracing the description of jointing cements. I have nothing really to tell you with regard to permeability, but I am glad to see—or rather I deduce from the Report—the fact that research men have finally damned straight fireclay for use as jointing material. There is no doubt whatever that, as stated in the Report, we must have tight joints with expansion material but not contraction. When we realize that temperatures in a setting may for hours reach something of the order of 1400° to 1440° C.—and the fireclay curve in the Report shows a tremendous contraction at points well below that—there is nothing to be said for the continued use of a fire-

clay. Some years ago we had failures of the jointing material at Beckton; and in order to obtain stability we cut out entirely the use of fireclay. We used straight silica rock—I believe I mentioned this some two years ago before the Institution—and we limited the fireclay to that containing something like 2 p.ct. of alumina. If you go above 2 p.ct. of alumina the contraction found at ordinary working temperatures within the period of the life of a retort, although possibly not within the period of a test result of 2 or 3 or 4 hours, is fatal. With 4 p.ct. of alumina we have had most drastic failures of the jointing material; and whether it be for silica retorts or fireclay retorts, I feel myself that we have only one material—namely, a straight silica—which can be used with any degree of permanent success.

There is one point here which I should like to say a few words about, and that is in discussing the tests of this material under prolonged heat, using the cement as a joint, the Report states, "In neither case did the joint show adhesion after the test." I believe they were using a silica cement, probably proprietary silica cement of something of the order of 2 p.ct. of alumina in one case, and in the other a mixture of corundum, silica, and clay. The failure of this material to adhere to the brick was one of the problems which presented itself when we were considering the suitability or not of this silica cement, and we attempted to satisfy ourselves what that condition really was. When you consider that heating a quartz, such as we used—a raw quartz, and not a heat-treated quartzite or crystobalite—you get something of the order of 5 p.ct. expansion, you cannot very well conceive how that material can key to the bricks and the pieces which it is asked to unite.

Experiments at Beckton.

We took small specimens, about 1 in. diameter cylindrical pieces such as we use for test pieces, and we cemented two of these small pieces with ⅛ in. joint and heat-treated them at various temperatures progressively, and then pulled them apart to obtain the real tensile strength of that particular joint. We found as we went up in temperature gradually that the strength increased. I am now speaking about a straight silica cement. There was continued adhesion of the joint and the block as we went up in temperature, and the tensile strength went up progressively as the temperature went up. When we arrived at about 1330° C. we got our maximum strength and also our minimum strength. I mean that if the joint held it registered the maximum tensile strength we could get. On other occasions, however, the joint simply fell apart due to the fact that in that particular quartz we had reached the crystobalite change. The quartz had gone to crystobalite and the cement failed to adhere. That did not satisfy us; we had burned our boats and had recommended silica cement and we were using it. Therefore, we wanted to know whether in actual practice it was going to pan out, and so we conceived that there might be some later action. If you can get, as you go up in temperature, increasing strength in these cement joints—for no adequate reason so far as I can see, because there was no liquefaction going on, and no vitrification to any great extent—until stopped by the fact that you get a very large expansion due to conversion, it did seem to imply that there was some action going on between the cement and the brick which we at any rate did not understand.

Therefore, we devised an experiment by taking two of these small cylinders in exactly the same way as before and cementing them and then enclosing them in a brick which we had drilled out to accommodate them. We then placed the brick containing the small cylinders in a combustion chamber, which was run at ordinary commercial temperatures—say, an average of 1370° C.—and we left it there for about a month. According to our experiments, if this material was faulty as far as the strength of the joint was concerned, these two pieces should come apart. But when we removed the brick from the combustion chamber after a period of about one month, we found that the jointing cement had its highest strength. In fact, the strength was such that we failed to pull it apart with the simple apparatus which had always been adequate for the other materials we had used. Therefore, in considering jointing cements, I think the research people should continue their researches with the view of expanding possibly, or supporting, that kind of evidence—*i.e.*, the strength which comes with continued use, whatever it may be due to. I myself have failed to find any adequate reason for this knitting together of the cement after it has once parted.

Permeability.

Mr. T. F. E. Rhead (Birmingham): I should like to congratulate the authors of this very valuable collection of papers which they have put before us. In saying so I am partly patting myself on the back, because I am a member of the Committee; but that is not intentional. In connection with permeability, we have been carrying out for a number of years some experiments on this property in connection with a larger investigation concerning the leakage from continuous vertical retorts. We have now got as far as dealing with the permeability to oxygen, hydrogen, carbon dioxide, nitrogen, and coal gas up to 1000° C. The results are not yet in sufficiently apple-pie order to be published, but I hope they will be very shortly. I can, however, quite safely say that this question of permeability is really not a serious cause of thermal loss in vertical retorts. What little loss there is is far overshadowed by the loss through parting joints and general leakage of retorts; but this work had to be done even if it gives that negative result. The loss by permeability is rendered still less by the deposition of scurf in the upper portions of the retort. Retort carbon is particularly impervious to the passage of gases. Similarly in the water gas zone of a vertical retort, after a very short period of working, the section to a varying depth is impregnated with ferruginous slag, which makes it what we describe as bottle tight, so that the chances of leakage by permeability are very small.

Hot Patching Cements.

This really leads to the next problem, hot patching cements which are needed very largely because of the leakiness of the joints in vertical retorts. Mr. Edwards has put forward a very interesting account of the use of pure quartz with a small amount of alumina and some sort of material to give it plasticity, as being a solution of this problem; but there is no doubt that when you are trying to patch a hole in the retort or to fill up a joint, you want some slight expansion to hold it in place. I have never yet been able to associate that with a material which would be satisfactory for building retorts, because if it gives 5 p.ct. expansion, on a 100 in. vertical retort you have 100 in. laminæ of the material which will give a total expansion of 5 in.; and my experience, which is confirmed by experiment, is that any jointing material of that description carries the bricks with it and helps to open the joints, which ride on the material as it expands. This is one of the difficulties in vertical retort construction. The jointing material used, it seems to me, must occur in step, in all its expansion, with the bricks that it is supposed to be jointing.

As regards hot patching cements as such, the problem is not only to find suitable material with the right degree of stickiness or tackiness, but the method of application needs some consideration. If we take a retort 25 or 27 ft. through, the position is not so bad a few feet down; but it is difficult when you get about half way across, because there is no tool which can be used with any degree of comfort or any degree of accuracy. Probably the best is the gun, either the pneumatic or one actually using banked shot. It has never appealed to me, however, to use patching materials in a wet form. I cannot feel it is a good practice to apply wet materials to a red hot retort. It seems to me that what we should aim at is to work these joints hotter and get the cement in position in that condition. With that object in view we have been trying to experiment in our test works at Birmingham. The idea has been to pass a dry powder or dry graded material down a tube and let that be met at the point of application in the retort by a stream of compressed air or air and coal gas—we are going to use, if we can, oxygen—and put a little carbonaceous material into the jointing material so that we can produce combustion and heat up the joint as the material passes into it. I feel that has an element of some success in it, but I would commend it to Mr. Green for criticism and consideration as to whether it is worth trying.

The Chairman: I should like to support the remarks of Mr. West with regard to the value of research work on refractories. It has been my privilege to visit the laboratories at Stoke-on-Trent, and I was very much impressed with what I saw and with the very useful work that was being done. Much more remains to be done, however, as we have heard this afternoon. Our only experience at Liverpool is, I think, generally speaking, that the jointing material is the weakest part of the job, and we want that improved. Then there is the question of the hot patching, which is an important one; and Mr. Green has that matter in hand. I was particularly interested in Mr. Edwards' remarks concerning jointing materials; there is no doubt that we shall have to improve jointing materials if we are to make any advance in retort bench construction.

The Author's Reply.

Mr. Green, replying to the discussion, said: In the first place, I should like to thank Mr. West for his very encouraging remarks. I should also like to mention that in our study of jointing cements we have the expansion curves more or less ready now, and they will find their way into

the Bulletin of the B.R.R.A. in the very near future, and also, I take it, they will find their way to the Institution of Gas Engineers.

I should like to thank Mr. Edwards for his interesting comments. Mr. Edwards and myself are old contestants. We do not necessarily see eye to eye in regard to jointing cements, but I can tell you it is my firm opinion that he is on the correct road. I am not at the moment willing to say whether he has gone too far along the road, but he certainly is in the right direction. The study of vitrification of materials leads us to the opinion that it is desirable to obtain a certain amount, or a fair amount, of that vitrification in a joint; and when one starts with almost pure quartzite together with a certain amount—say, 2 p.ct. of lime—I take it you get vitrification reasonably quickly, through the action of the retort. At the moment, however, I cannot make up my mind whether that takes place. Mr. Edwards is perfectly convinced that it takes place with horizontal retorts. Indeed, he has demonstrated that to me at his own works, and consequently I take his opinion. In the case of vertical retorts, however, my own experience has not led me so directly to that opinion, and I am rather inclined to agree with Mr. Rhead that the problem is not quite so easily solved. Nevertheless, I am particularly interested in the tests that Mr. Edwards has put forward, and I can assure him that based upon much of the conversation that I had with him two or three years ago, we have carried out a great deal of work. In other words, we have adopted tests measuring the tensile strength of joints, and we shall probably evolve further tests based upon the suggestions which he was good enough to give me.

Different Cements for Different Zones.

As far as the stickability of joints is concerned, again that depends upon vitrification to some degree, and I have found, on examining retorts on many occasions, after the retorts have been in use for two or three years, that the joints are not necessarily stuck together. You can pull two or three bricks apart in certain zones, although not in all zones; and that brings me to the opinion that we want a different type of jointing cement for the different zones in a retort. In other words, we want to develop different cements for different zones, where we know the actions are essentially different. That is one of the basic considerations of my work at the moment.

I should like to thank Mr. Rhead for the continued encouragement he has given me, and particularly in connection with the early portion of our work on permeability. He was kind enough to present to me all his work that had been done so far on this problem; and, believe me, it was intensely helpful at the start of this study of permeability. I agree with Mr. Rhead definitely that in the study of vertical retorts the joints have to follow the principles I have just tried to deal with in connection with my remarks on Mr. Edwards' comments.

I should like, in conclusion, to thank the Chairman for his encouragement. When he was at Stoke-on-Trent visiting our laboratories he was particularly encouraging in his remarks on the progress of the work, and we thank him very much.

Written Communications.

Mr. C. W. Thomas (Chairman of the British Refractories Research Association), in a written communication, states: I have followed with very great interest the work of the Refractory Materials Joint Sub-Committee ever since its inception; and as one who took an active part in its earlier meetings pre-war I have watched with a great deal of satisfaction the progress that has been made and the greatly increased interest that has from year to year been taken in its proceedings. No one will question the value to the Gas Industry of the results of its work and the beneficial effect which it has had upon the life of refractories as applied to gas production.

The 22nd Report seems to me to be fully equal to former ones. I am more especially interested in the papers on the action of carbon monoxide on refractory materials, because it appears to confirm the opinion which I have for many years held, as to the great importance of completely oxidizing conditions during the firing of fireclay refractories, particularly in the later stages. It seems fairly clear, from the results tabulated by Mr. Green and his co-workers, that anything approaching reducing conditions in a kiln tends to leave any iron present in the clay in the form most open to attack from CO. I believe that it will be found that the particular form in which the iron exists in its native state has a marked bearing on the problem, and, in any case, that the disintegrating effects under working conditions will be much less marked where the brick or block has been fired under definitely oxidizing conditions.

As Chairman of the British Refractories Research Association, I am frequently asked, "In what way has the work of the Association benefited this, or that, industry? Can you give any instances of specific good results?" I believe that the Gas Industry shows very markedly beneficial results from our work, and in the papers to which I have particularly referred you have, I think, a typical instance of the way in which the conclusions, arrived at by our research workers, may still further improve the refractories which you use, by indicating the proper lines on which manufacturers may with advantage proceed. I believe also that the papers on permeability will be of value in enabling us to strike a satisfactory balance between the advantages of low permeability on the one hand, and the risks of spalling on the other.

I may perhaps be allowed to say, in conclusion, how greatly the Council of the Refractories Research Association value the support of, and the keen interest shown by, the Institution of Gas Engineers.

Mr. A. H. Middleton (Consett Iron Company, Ltd.), in a written communication, states:

I have found that the report requires a great deal of digestion, and I do not claim yet to have looked into it so fully as it deserves. It is unnecessary to emphasize the desirability of this kind of joint work between the manufacturer and the user, but I have noticed in some of the Research Associations there is a reluctance which is very noticeable of subscribers to maintain their subscriptions. I consider that the work in progress needs every encouragement, and therefore appeal to all subscribers to continue their support in spite of the present difficult times.

Although I cannot find in this report anything definite at this stage of the work which will enable the manufacturer to improve the quality of his products or help the carbonizing engineer to modify his methods in order to attain increased service, I look forward to the continuation of these investigations eventually providing something tangible from the practical standpoint.

I would like to ask if it would not be possible to carry to a definite conclusion some particular problem of general interest to the carbonizing engineer and the refractory materials maker, such, for instance, as the local disintegration in vertical gas retorts, on which a certain amount of useful work has already been done. I believe that this local disintegration, erosion, or spalling, or whatever name one chooses to use, occurs in every type of vertical retort and with every type of silica material, although it occurs at different zones in various designs of vertical retorts. The trouble in most cases is very local, which proves that it is not due to any general unsuitability of material or any general fault of retort heating, but is a particular trouble due to a combination of circumstances at one particular part of the system. I believe, but I am not sure, that the particular trouble that I refer to is always associated with steaming, and it is interesting to note that it never occurs, as far as I am aware, in coke oven carbonizing practice. I think it is likely that work dealt with in these reports in connection with the disintegration and permeability of refractories may be found to have a distinct bearing on this subject, but if it is possible I should like to see some concentrated work done on this particular type of trouble, as I feel that, if some particular industrial problem could be definitely helped as a result of the work of the Refractories Sub-Committee and Refractories Research Association, we should hear less of the difficulties in keeping up contributions to the working funds of such Associations.

Semi-Direct Recovery of Ammonia at Gas-Works

Supplement by Mr. ALFRED L. HOLTON (Chief Engineer, Manchester Corporation Gas Department) to his Institution Paper on "The Semi-Direct Recovery of Ammonia in Gas-Works Practice, and the Recovery of Tar Acids from Ammoniacal Liquor" (Communication No. 29)

A description of the dephenolating plant was given in a paper read before the 68th Annual General Meeting of the Institution of Gas Engineers in June, 1931, entitled "The Semi-Direct Recovery of Ammonia in Gas-Works Practice and the Recovery of Tar Acids from Ammoniacal Liquor" (Communication No. 29), and the following working results are given in fulfilment of the promise made at the conclusion of that paper. Two photographs of the plant are now presented (figs. A and B).

The process consists of preheating the gas liquor to 45° C. and washing it with benzole on the counter-current principle in the ratio of 60/70 parts of benzole to 100 parts of liquor, by volume, in a tower fitted with perforated trays.

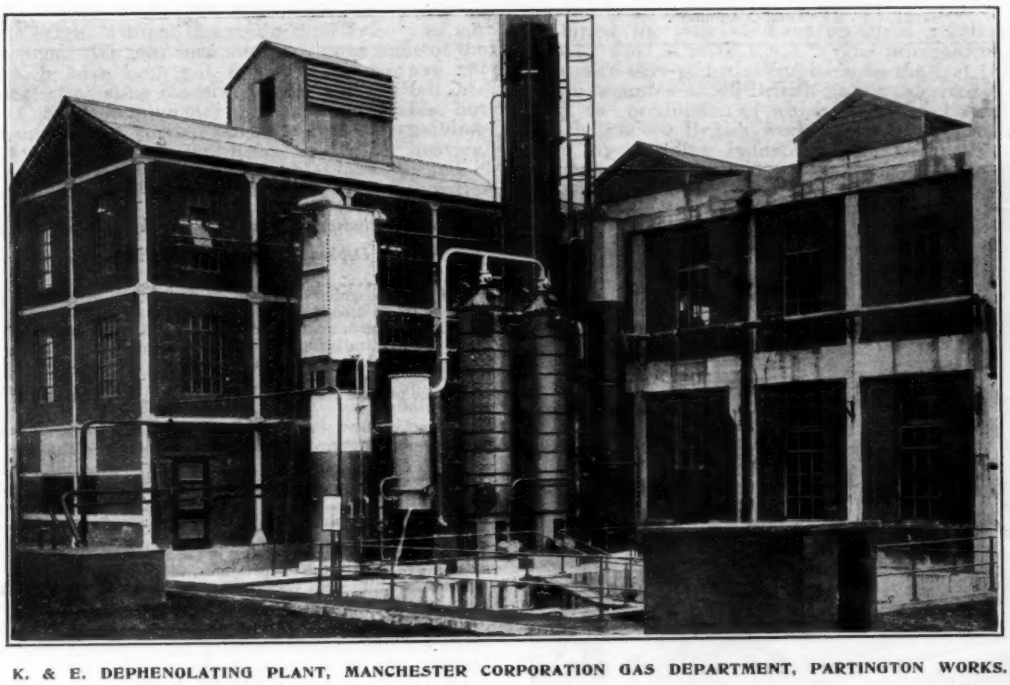
The plant has been continuously at work since Sept. 1, 1931, and the results tabulated are therefore based on a run of two months' duration.

Smooth and consistent working has been one of the most noticeable features of the plant. Further experimental work is being undertaken, but with the high efficiency at present being obtained from the plant no drastic improvements can be expected.

Attention has been drawn in Reports Nos. 4 and 5 of the Liquor Effluents Sub-Committee by Dr. Parker and Dr. Monkhouse to the fact that the successful commercial operation of a dephenolating plant depends largely upon the quantity of benzole lost in the process, and for this reason the plant at Partington includes activated carbon filters for the extraction from the dephenolated liquor of the dissolved benzole.

There are two carbon filters—worked alternately for periods of 48 hours—the benzole being recovered from each in turn by steaming while the filter is out of action. The liquor leaving the washer, prior to entering the carbon filters, has a benzole content of 1·1 grms. per litre and after passing through the filters of 0·25 grm. per litre, a recovery of 0·85 grm. per litre.

On the present treatment of 16,800 gallons of liquor per diem, the amount of benzole recovered is 16 gallons per diem, which would otherwise be lost in the process. Two qualities of activated carbon are in service, but the working period under review is of too short a duration to estimate their respective values. The benzole still incorporated in the process is of the type patented by Mr. W. G. Adam, of the Gas Light and Coke Company.



K. & E. DEPHENOLATING PLANT, MANCHESTER CORPORATION GAS DEPARTMENT, PARTINGTON WORKS.

Chief Engineer, Alfred L. Holton; Contractors, W. C. Holmes & Co., Ltd.

The actual loss of benzole is so small that it can only be ascertained over long periods, the stock in the storage tank being affected by variations in the amount of benzole in circulation. The stock of benzole in the storage tank on Sept. 6 (when the plant was working normally) compared with that on Oct. 26 shows a loss of 10·2 gallons per diem.

It may be of interest to note that the benzole as delivered tested I.B.P. 79° C., 91 p.ct. at 100° C., dry 120° C., while that which has been in circulation for two months tested I.B.P. 76° C. dry at 95° C.

The final purification of the waste liquor obtained by the dephenolating plant gives an oxygen absorption efficiency of 70 p.ct. The isolation and circulation of the first 5 gallons of condensate per ton of coal carbonized is now embodied in the scheme at Partington, but it has not been in operation for a sufficient length of time to

give working details, and it is important to bear in mind that the results shown in the tables submitted are prior to the incorporation of this process.

The addition of the ammonium chloride process, since it withdraws 12 p.ct. of the original liquor containing the main proportion of the higher tar acids, will give a total diminution of the oxygen absorption bodies of approximately 85 p.ct., for it is the higher tar acids that present the greatest difficulty in the benzole washing process.

No special comments are necessary on the working of the other parts of the plant, and the working details are tabulated in the three following tables:

TABLE No. 1.

Analyses of Liquor Taken at Various Points of the Dephenolating Plant, Partington Works.

Condensate from Secondary Condensers. (Devil's Liquor).		—	Untreated Liquor from Primary and Secondary Condensers.		Liquor Entering Carbon Filter.		Dephenolated Liquor after Carbon Filter.		Waste Liquor.	
Grm. per 100 c.cs.	O/A.		Grm. per 100 c.cs.	O/A.	Grm. per 100 c.cs.	O/A.	Grm. per 100 c.cs.	O/A.	Grm. per 100 c.cs.	O/A.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
0·0280	..	Sulphide calculated as H_2S	0·0174	..	0·0116	..	0·0117	..	..	..
0·0097	8	Thiosulphate ,, ,, S	0·0194	17	0·0192	17	0·0154	13	0·0121	10
0·039	32	Thiocyanate ,, ,, CNS	0·020	17	0·025	21	0·046	38	0·035	29
Nil	..	Fe $(CN)_6$	Traces	..	Traces	..	Traces	...	Traces	..
0·236	420	Phenols ,, ,, C_6H_5OH	0·470	837	0·033	59	0·034	60	0·019	34
..	12	Balance (due to higher tar acids)	..	494	..	363	..	355	..	172
..	472	Total O/A found	..	1365	..	460	..	466	..	245

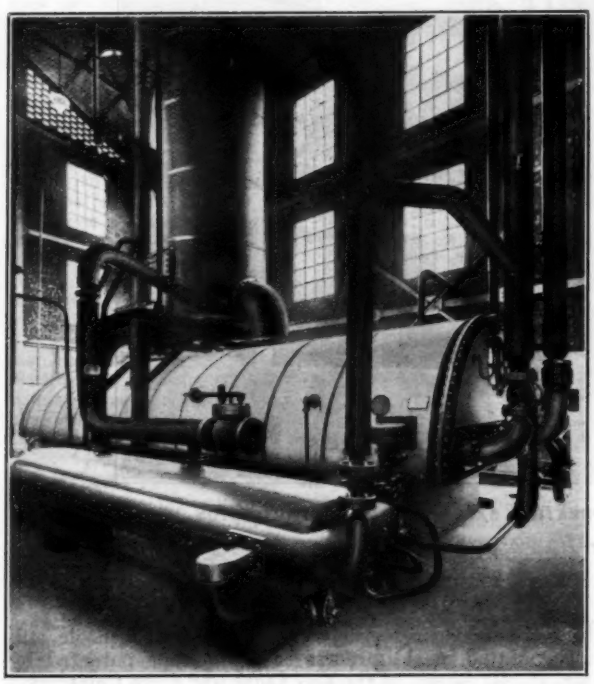


TABLE No. 2.

Commercial Yield from the Crude Phenols Produced at the Partington Works.

	By Volume. Per Cent.
Water	0·5
Neutral oil	9·5
Crude carbolic acid (60's)	52·0
Cresylic acid	21·5
Higher boiling tar acids	10·0
Pitch, residue, and loss	6·5
	100·0

TABLE No. 3.

Data, including Capital and Working Costs, Relating to Dephenolating Plant, Partington Works.

Liquor throughput (average) . . . . . 16,800 galls. per diem
Live steam used in process . . . . . 16·4 tons ,,
Exhaust steam used in process . . . . 13·2 tons ,,
(Efforts are being made to increase the amount of exhaust steam used and reduce the live steam.)
Crude phenols recovered . . . . . 80/100 galls. ,,

Phenol content . . . . . 4·70 grms. per litre
Phenol recovery . . . . . 4·36 grms. ,,

Benzole (required for circulation and allowance for small working stock) . . . . 6000 galls.

Activated carbon in filters . . . . . 2 tons

Labour.—The labour entailed in the general working of the plant is the reading of the temperatures, which is undertaken by the sulphate still man. General cleaning up by a youth—one hour per day—and running off the phenols twice per day by general shift foreman.

CAPITAL COST.

	£
Foundations (high cost due to removal of deep peat bed)	2200
Steel framed building	700
Storage tanks, floor plates, handrails, &c.	400
Complete plant and connections (capacity, 120 tons per diem)	4500
	£7800

Extra Costs Incurred at Partington in Respect of Working the Dephenolating Plant.

	Per day. £ s. d.
Expenditure—	
Live steam, 16·4 tons at 2s. per ton	1 12 9
Benzole loss, 10 galls. at 1s. 8d. per gall.	0 16 8
Interest and sinking fund charges—	
Foundations and building £2900, 6½ per cent. 30 years	..
Plant, &c., £4900, 8 per cent. 20 years	1 11 10
	£4 1 3

Repairs and renewals / Renewal of carbon } No information available, but should be very low.

Revenue—
To meet the above expenditure, there would be the revenue derived from the sale of the crude phenols.

British Road Tar Association

ADDRESS BY SIR DAVID MILNE-WATSON, D.L., LL.D.

At the Fourth Annual Meeting, on Nov. 3

Out of all that has happened during the last few months there has emerged the pressing need both for a balanced Budget and a restored balance of trade. These two needs are not without their particular significance to the Industry with which we are connected. A balanced budget has necessitated drastic economies, and among them a slowing up, if not a cancellation, of many projected road schemes. A restored balance of trade can only be achieved, apart from other factors which do not concern us here, by the utilization, wherever possible, of products of home origin and home manufacture in preference to products of foreign origin and foreign manufacture.

The Prime Minister recently defined the true meaning of economy in its application to our national problems. His plea was that we should continue to spend, but to spend wisely, and that plea has been wholeheartedly supported by industrialists and economists throughout the country. Of recent years, road construction has become the catspaw of political parties for finding work for the unemployed, but in future, stricter utilitarian and economic considerations must prevail.

I think—in fact I can go so far as to say—that it will be generally admitted that we can economize to a very considerable extent without impairing the efficiency of our highway system. We may be able to postpone some of the schemes which have been put forward, but we can *not* afford to neglect existing roads and allow them to fall into disrepair. Cost of maintenance may be considerable, but if maintenance is not carried out, the cost of rebuilding broken down roads a few years hence will be far heavier. We need rapid and safe transport now as always, and it is essential for the well-being of industry that authorities everywhere should take the long view, and in the spirit of the Prime Minister's advice, spend wisely.

Too Much Reliance on Imports.

It is a common trait of the British character to belittle our own achievements. In the last few years we have seen the foreigner compete successfully in our own markets, and as a nation we seem almost to have come to believe that, in certain respects at any rate, foreign products are better than any we actually do produce or could produce ourselves. We have come to rely too much upon imported materials, and we have gravely neglected our own wide resources. The present crisis may serve to restore a saner balance. I submit that there is need for a better understanding of the inherent possibilities of the national resources of the country to fulfil our roadmaking requirements. The stone from British quarries, the slag from British furnaces, the tar derived from the carbonization of British coal, are the paramount materials. Quite recently in the House of Commons the Minister of Transport said he deplored the use of foreign road material in this country. He promised, to use his own words, "to issue a further circular urging those responsible for these purchases to review the position in view of the present grave situation," and he concluded by saying: "If there are people in this country who are able to supply first-class materials at the same price or at a less price than materials from abroad, he hoped they would press on with it."

Our richest raw material, and the basis of our industrial prosperity, is coal. Do we make the fullest use of it? Not yet—but I hope and believe that in the next few years we shall. Of all the bye-products derived from coal, tar is without question one of the most important. Leaving aside the innumerable derivatives obtained from crude tar, let us concentrate solely on road tar.

During the last decade British road tar has suffered intense competition from materials of foreign origin, but it is claimed, and I think the claim is justified, that British tar and British stone and slag will build roads as fine as any to be found in the world.

An Opportunity.

To-day we have a magnificent opportunity of demonstrating the quality and the relative cheapness of tarred roads. In the national interest, we should and must use more tar on our roads. By doing so we save on imports and thus help not only to give increased employment in this country, but also to correct our adverse balance of trade.

I am glad to say that I find myself in good and growing company in my advocacy of the use of British materials. Some months ago, Lord Jessel as President of the National Union of Ratepayers' Associations, sent a letter to the Press, which was widely used, in which he said: "It is obviously a matter of the greatest importance to purchase materials as far as possible in the locality of the work, or at least to make certain that the materials used have been made in Great Britain, or consist of British raw material." And again Lord Bertie of Thame, President of the National Federation of Property Owners and Ratepayers, "Materials and methods are encouraged that are twice or three times as expensive as is justified by the needs and resources of the country in these difficult times. Simple materials, such as British tar and British stone, would have provided adequate highways, and incidentally would have given more local employment, to the further relief of the rates."

Mr. F. J. Nellensteyn, Director of the Government Roads Laboratory, Holland, praises the excellence of our roads. "A point which attracts the attention of the foreigner," he says, "is the high quality of your tarmacadam roads. This must be due entirely to the quality of British tar—and to the quality of your slag or broken stone, as the method of construction is about the same as on the Continent."

During the year we have produced a talking film entitled "Coal Mine to Road." The principal object of this film is to give pictorial emphasis to the fact that we have in this country an all-British product derived from British coal, the production of which gives direct employment to nearly 200,000 British workpeople in the gas, coke oven, and tar distilling industries, and indirectly as well to 800,000 miners. The film is a reminder that British tar, stone, and slag are available in all parts of the country, and when, therefore, local authorities build and maintain roads with these materials, not only is work being provided for their own local workpeople, but at the same time their use is giving a welcome fillip to local industry. Perhaps most important of all, the money expended is being kept in this country.

A Record of Progress.

As an Industry, however, we are fully alive to our obligation to those who purchase our materials. One of the principal objects of our Association is that it affords a central meeting place where we can work together to improve our product and at the same time explore new developments which can be placed at the disposal of road authorities throughout the country. That work is far from complete, but again this year we can show a record of progress towards the end we have in view. We want the confidence of our customer, and I am glad to say that I believe there is a growing and genuine appreciation of what we are doing.

In March there was issued the British Standard Specification for Tar No. 3. This specification was drafted by the Technical Committee to produce a tar which would facilitate quick setting, and so better enable users to meet continuous and heavy traffic conditions. A draft and road Specification for road emulsions, tar, pitch, and mixtures has also received further consideration, and several problems which have arisen in connection therewith are being carefully studied. Progress is being made with proposed Standard Specifications for the construction of roads with tarmacadam and for the maintenance of roads with tar. The Technical Committee has continued its work of investigation into the surfacing of concrete roads with tar, and during the year we have revised and re-issued our recommendations for the surface tarring of waterbound and previously treated roads.

Our demonstration work has included the laying of two stretches of tar concrete—one of granite and one of slag—on the Kingston By-Pass, under the auspices of the Ministry of Transport, and co-operation with the Ministry in surface dressing demonstrations on the Sunningdale-Bagshot road and the Leicester-Melton Mowbray road.

At the invitation of the County Surveyor for Cumberland, a stretch of road approximately 500 yards in length was surface dressed with tar on the main Carlisle-Glasgow road last autumn, with entirely satisfactory results. In immediate prospect we have a demonstration road in the West Riding of Yorkshire at the invitation of the County Surveyor, and we have just completed a demonstration surface dressing of asphalt in the Royal Borough of Kensington, at the invitation of the Engineer and Surveyor.

It is hoped the conducting of joint experiments and demonstrations with prominent surveyors will become more

and more a feature of our work, and I should like to take this opportunity of expressing to them through the Press our desire for their co-operation in this direction, which we regard as one of the most important branches of our work.

I might also mention here that through the International Road Tar Conference, which has been brought into being on our initiative, we hope to keep in as close touch as possible with developments in road tar technique in all parts of the world, to the benefit wherever possible of our own industry in this country.

Road Tar Research Committee.

Another activity which we are now commencing and which we consider of the greatest importance is the creation, at the invitation of the Department of Scientific and Industrial Research, of a Special Road Tar Research Committee, under the Chairmanship of Sir Robert Robertson, Government Chemist. Under this arrangement research work on road tar and road problems, in so far as they concern tar, will be carried out by the expert staff of the Department, and we look forward, through this work, to rendering a further service to the road industry of Great Britain.

As I have already said, we want the confidence of our customer, and we are doing our utmost within the limits of the funds at our disposal to merit it.

This brings me to my concluding remarks, which are addressed to those within the Tar Industry.

We all hope that the coke oven industry, to whom we must look for any substantial increase of revenue in the future, will identify itself still more closely with the Association's work. Their whole-hearted support is of the greatest importance to our future progress and with a growing realization of the potentialities of road tar, we hope that they will give full support to the Association which has, and is, promoting the interests of that product through a difficult, if not critical, period. To those firms and undertakings that are still not subscribing to our funds, I should like to say that it is my considered opinion that they should no longer stand aside, in a matter in which they are so vitally interested. When reviewing the achievements of this Association during the last four years, there can be no question that its activities are essential to the welfare of road tar in this country, and that the amount of labour and money which has been expended has been of great benefit to the tar industry. The Association has more than justified itself, and I am convinced that it will continue to do so in the future.

THE "COBBLE BEAM" GAS FIRE

Radiation's Latest Achievement

When Radiation Ltd. published their booklet "Radiant Heat and Comfort" in 1928, at the time of the introduction of the "Beam" radiant, it became realized by the Gas Industry that the researches initiated in their Central Laboratories would probably lead to a revolution in our ideas concerning the gas fire, and, in fact, the general problem of domestic heating. It had been known for a number of years that the Radiation Laboratories were investigating the quality of the energy emitted by the gas fire, and were also concerned with the possible therapeutic value of infra-red energy. At the conclusion of the booklet "Radiant Heat and Comfort" it was stated that the "Thermo-XX Beam" radiant represented only a first step forward in the direction of improving the quality of the energy emitted by the gas fire. These investigations have been continued, and a further advance has been signalized by a most important development which was demonstrated to a large number of members of the Gas Industry who visited 15, Grosvenor Place, on Tuesday and Wednesday, Nov. 3 and 4.

Increase of Short Infra-Red Energy.

Radiation Ltd. were the first to establish the importance of ensuring that future developments of the gas fire should be in the direction of increasing the emission of short infra-red energy. They experimented with a large number of materials for radiants and with other materials for treating radiants. Their investigations led to the development of the "Beam" radiant and later to the discovery of mixtures of inorganic compounds which could be used in conjunction with these radiants to increase the emission of energy capable of penetrating the human skin. The requirements of manufacture limited the extent to which development in this direction could be effected, and it was

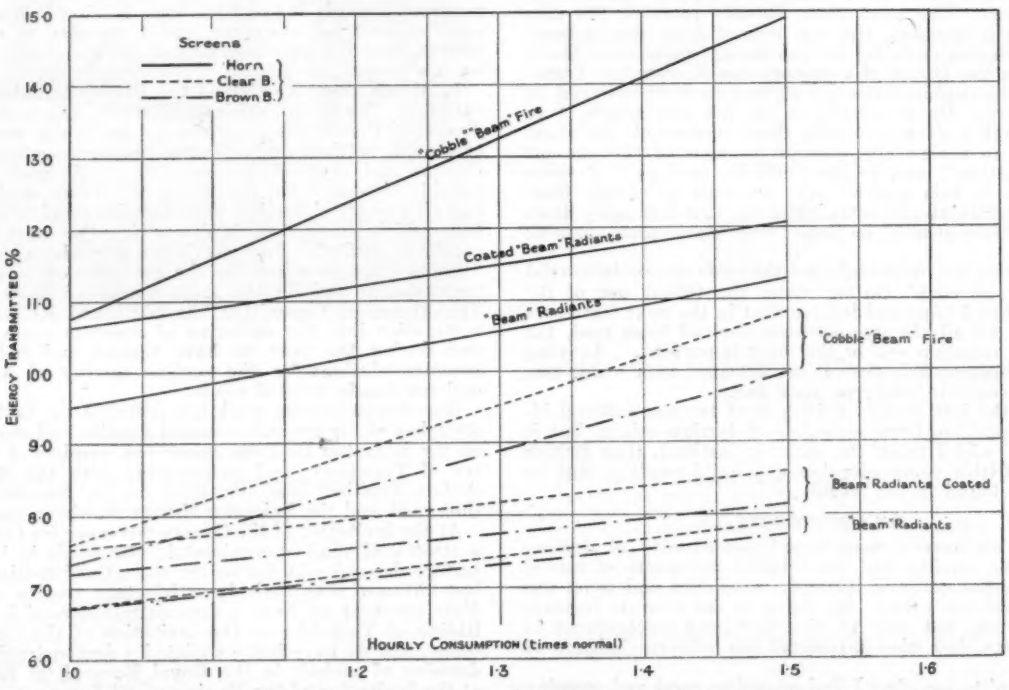
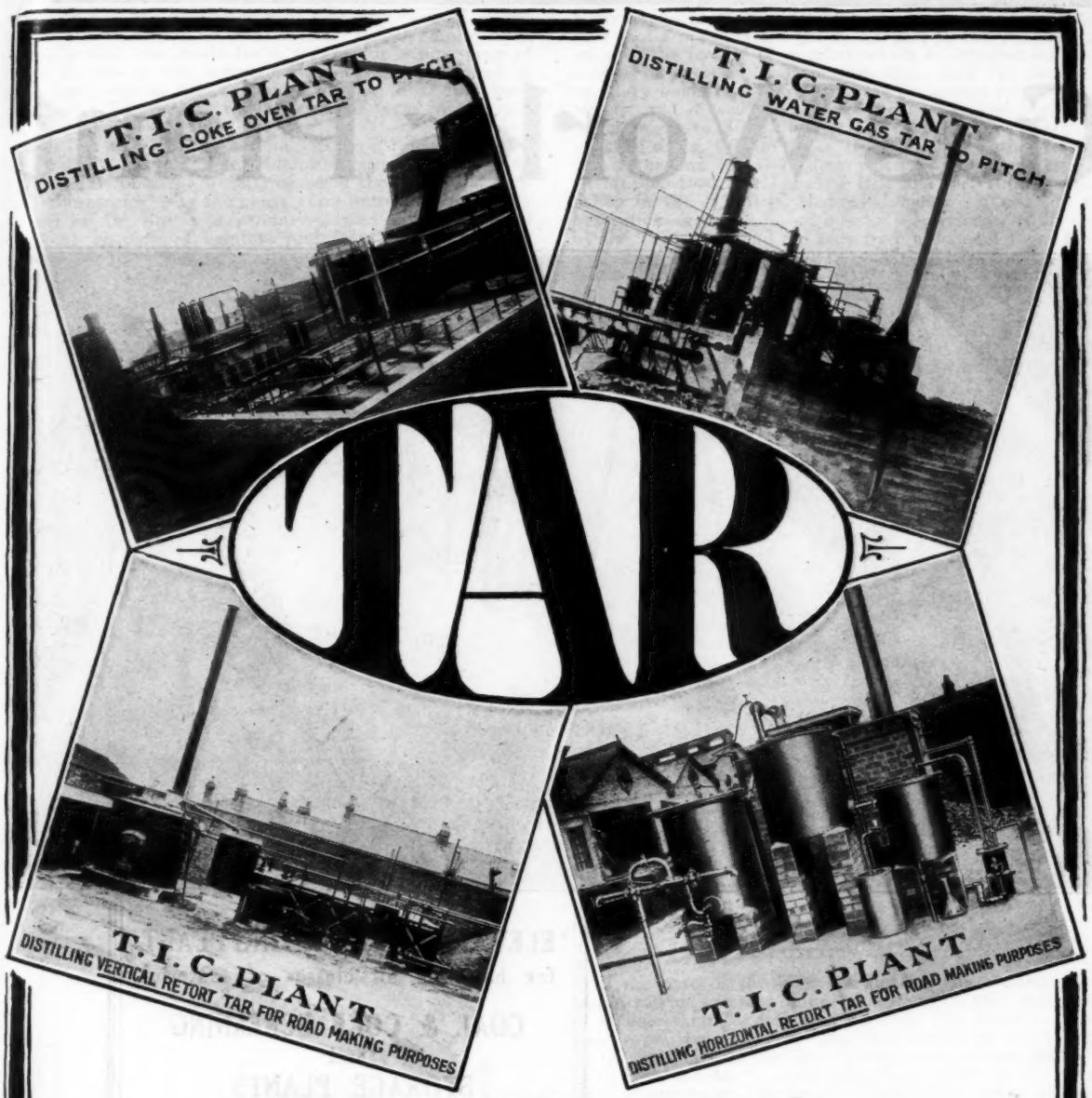


FIG. 1.—COMPARISON OF ENERGY TRANSMITTED WITH "BEAM" RADIANTS, COATED "BEAM" RADIANTS, AND THE "COBBLE BEAM" FIRE.


T.I.C. PLANT
DISTILLING COKE OVEN TAR TO PITCH
T.I.C. PLANT
DISTILLING WATER GAS TAR TO PITCH
TAR
T.I.C. PLANT
DISTILLING VERTICAL RETORT TAR FOR ROAD MAKING PURPOSES
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realized that it would be necessary to devise a radical change in gas fire construction if real development in the desired direction were to be attained. In November, 1928, an application was made for a patent for a new type of fire. Details of the complete patent were published in May, 1930, but in the meantime further ideas had been developed. These have taken practical form in the new "Cobble Beam" fire.

There has been issued a second brochure, "Radiant Heat and Comfort, Part II.," in which has been collected some of the results of these investigations in the Radiation Central Laboratories. As the penetrative power of the energy emitted by the fire is of primary importance, both from the point of view of comfort and from the therapeutic aspect of the matter, a comparison has been issued of the penetrancy of the energy emitted by the new fire as compared with a standard Radiation fire fitted with "Beam" radiants and another fire fitted with coated "Beam" radiants. These results are given in fig. 1.

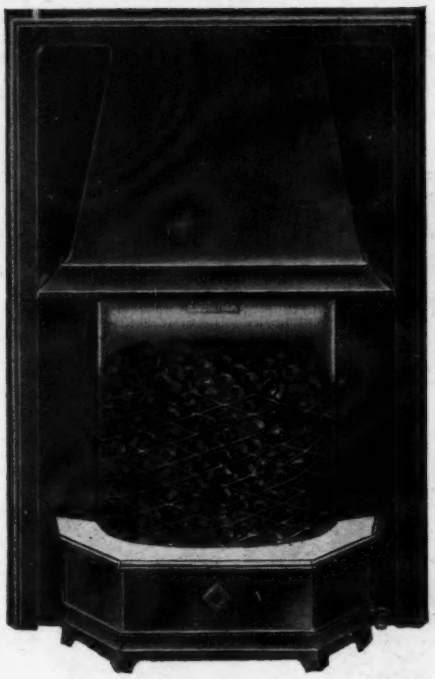


Fig. 2.—The "Cobble Beam" Fire.

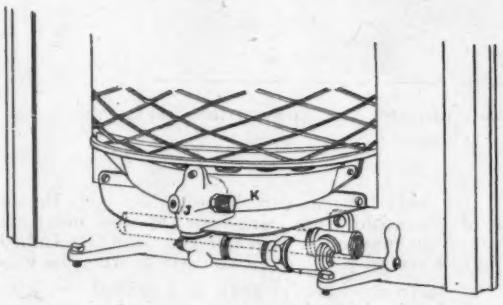


Fig. 3.—Arrangement of Burner.

Death of the Scorching Bogey.

The introduction of the "Beam" radiant provided the quietus for the scorching bogey applied to the gas fire, and gas salesmen do not now meet with adverse criticism of the gas fire in comparison with any other form of domestic heater. While the general public to-day realizes that the gas fire is as good as any other form of radiant heater, we can safely prophesy that the work of the Radiation Central Laboratories is well on its way to effect a general recognition that the gas fire is really the best heater available. Radiation Ltd. rightly stress the importance of ensuring that the energy emitted shall be capable of penetrating the epidermis. The more penetrative the energy, the more rapid would appear to be the stimulation of the capillary blood-flow which is effected. It is a consequence of the stimulation of the capillary blood-flow that a moist skin is produced, and to this phenomenon we owe the feeling of comfort which is experienced when seated in front of a Radiation fire. But the increased capillary blood-flow may have very important physiological effects, and it was this belief which led to the suggestion being made to Sir Leonard Hill that he should try the effect of using "Beam" gas fires in place of other irradiators in certain investigations which he was carrying out. In March, 1930, Sir Leonard Hill and Dr. Eidinow published in the "British Medical Journal" a note on the protection against a lethal dose of staphylococcus afforded by short infra-red and red rays from a "Beam" gas fire—a protection which was not attained with a dark heat source. This result is one which will probably prove of outstanding importance to the Gas Industry, as it definitely marks the establishment of a therapeutic effect attained with a gas fire.

The next step which should be recorded is the production of an appliance intended solely for use for therapeutic purposes—the Radiation clinical gas lamp. In the development of this lamp there were applied the results of the investigations which had been carried out on the increase of penetrancy of the energy attainable by the treatment of "Beam" radiants with inorganic compounds. Reference was made to this lamp in our issue of Oct. 21, p. 200, and it was then mentioned that these clinical gas lamps had been found effective in eliminating acne and providing a useful palliative for persons subject to rheumatism.

Many of the sources used for ultra-violet ray irradiation actually emit a preponderating amount of short infra-red energy, and it seems not unlikely that in certain cases the short infra-red energy is playing an important part in the results attained consequent upon the flushing of the skin which results from the increased capillary blood-flow. Infra-red energy treatment has the advantage that it can be undertaken by laymen without fear of accidental over-exposure, whereas ultra-violet ray treatment should not be carried out because of the risk of unpleasant after-effects. The aim of Radiation Ltd. is to develop the gas fire so that it shall possess the advantages, so far as the quality of the energy is concerned, of appliances primarily designed for therapeutic purposes, so that the general public shall realize that the Radiation gas fire is not merely better than any other type of heater, but is actually beneficial. A comparison of the penetrancy curves for the "Cobble Beam" fire with those of the clinical gas lamp shows that the energy emitted by this new gas fire is but little inferior to that of the clinical appliance in its power of penetrating the epidermis.

Distribution of Heat.

In the case of the domestic heater, the attainment of comfort is of primary importance, and in this connection it is necessary to consider not only the quality of the energy emitted, but also the distribution of the energy, as the intensity of the heat falling on a person seated in front of a fire has a most important effect on the sensations experienced. To ensure better distribution, the configuration of the radiant mass of the fire has been completely modified. By using for the front of the "Cobble Beam" fire a configuration which Radiation Ltd. first introduced many years ago, and by extending the incandescent surface in a backward direction as they had done originally in some of their inset fires, the desired result has been attained (see fig. 2). The use of the cobbles, eliminating as they do the fragile radiant which has hitherto characterized the gas fire, removes that appearance of artificiality to which exception is sometimes taken on æsthetic grounds, while the construction adopted gives in addition the effect of a deep incandescent bed, which is such a pleasing feature.

It is, of course, hardly necessary to remark that particular attention has been paid in the design of the fire to ensure that there shall be adequate ventilation of the room. The form of the "Cobble Beam" fire has lent itself to the adoption of quite a simple construction to attain the standard of ventilation laid down for Radiation appliances.

One striking advantage of the fire is in the complete elimination of the noise, which is noticed with the ordinary type of gas fire due to the characteristic injector hiss and the resonance effect produced by the burner body. A tap has been standardized for supply with the fire, and this tap also is so constructed that as the gas consumption is reduced it shall not set up any noise. In the "Cobble Beam" fire we really have a completely silent gas fire.

We have already referred to the introduction of this fire as a most important development. The introduction in 1923 of the "New World" Cooker enormously widened the field of use of the gas cooker. It may not be too much to expect similar results with this "Cobble Beam" fire, which is sure also to become a prototype.

HELPING THE CAUSE OF INTERNATIONAL GOODWILL

Further Notes on the A.G.A. Convention—Atlantic City, Oct. 12-16

We have now received, through a member of the American Gas Association, a New York Correspondent, and our esteemed contemporary the "Gas Age-Record," of the U.S.A., further details of the programme and proceedings at the Gas Convention at Atlantic City, and of Sir Francis Goodenough's visit to America, last month, that will be of particular interest to readers on this side.

The first striking piece of news is that the attendance of delegates at the Convention reached the amazing figure of nearly 5000, or more than 80 p.ct. of the record attendance in a year when, owing to industrial and commercial depression and the urgency of economy in all directions, the attendance at annual Conventions in the States rarely reached 50 p.ct. of the normal. This fact was naturally very gratifying to the President (Mr. Clifford E. Paige) and all the Officers of the A.G.A.

MR. CLIFFORD E. PAIGE AND SIR FRANCIS GOODENOUGH OUTSIDE THE CONVENTION HALL.
Lady Goodenough and Mrs. Paige are behind them on the left.

The second interesting item of news is the warmth of the welcome given by the Convention to the Chairman of the B.C.G.A., who was attending as the special guest of the American Gas Association. Its Officers had been trying to get Sir Francis over to their meeting for some years, particularly since he and Mr. Le Roy Blanchard, of New York, acted as joint Chairmen of the Public Utilities Section of the World Advertising Convention at Wembley in 1924, and a number of the leading gas administrators of America enjoyed hospitality at the hands of Mr. Goodenough, as he then was. But allowing for all his pre-knowledge of the friendliness of his American Colleagues and his experience of their kindness and hospitality since his arrival in New York a week earlier, we can picture the surprise and embarrassment occasioned to Sir Francis when, on being called upon by the President to address the crowded General Session of the Convention, the audience, as we learn from the "Gas Age-Record," rose, gave him "a thunderous welcome," and then stood while the organ played the British and American National Anthems.

Sir Francis was down on the programme to read a paper on "The Economics of Selling Gas," but from the stenographer's report of his speech we learn that he at once assured his audience that he had no intention of boring them by doing any such thing, and our correspondent tells us that the audience greatly welcomed, in the place of a statistical disquisition that they had expected, a human and friendly address of an entirely different nature.

Salvation Only Through Contact and Mutual Service.

After expressing his great pleasure at being amongst them and congratulating the Association on the attendance in such times and in such weather (which was of the finest), on their wonderful exhibition, and on their President, Sir Francis referred to his earlier associations with many of their leaders—notably Oscar Fogg, Bernard Mullaney, Frank Blanchard, Merton Robbins, and Alexander Forward—and said: "I was very happy when your President spoke of Friendship as being one of the outstanding features of my connection with the American Gas Industry. I am in full accord with one of your poets when he wrote:

> "More precious far than gold refined
> Is friendship, knit with heart and mind;
> Gold may go its fickle way [as we have just experienced in England],
> But friendship, tried, will ever stay."

After comments (which were much appreciated) on New York, American women, and Prohibition, the speaker proceeded to express his indebtedness to America as a whole and to the American Gas Industry in particular for much inspiration and help throughout his business life. His statement that, "As a school boy I was one of your rebels. Had I been here in the early days I would have enlisted under Washington. . . . Franklin, Washington, Lincoln have been among my heroes all my life," as can be imagined, "brought down the house" and ensured a very sympathetic and cordial reception for the conclusion of an address which we know gave particular pleasure to two British colleagues who were on the platform with him—Arthur Hewitt, of Toronto, and Herbert Canning, of Newport, the President of the British Institution of Gas Engineers. Sir Francis ended by saying:

"There is no competition between us in the Gas Industry on both sides of the Atlantic, except the competition

to serve the public more and more efficiently. As one of your poets wrote:

"Not chance of birth or place has made us friends,
Being often times of different tongues and nations,
But that we endeavour for the self-same ends,
With the same hopes and fears and inspirations."

"That is the common bond between the British Gas Industry and the American Gas Industry.

"There is a great need for goodwill and co-operation between all of us in both nations in order to overcome the difficulties of the present situation. Those difficulties are nothing but temporary on either side of the Atlantic. Both countries are sound in wind and limb. There is no occasion for any of us to be disheartened. I think that what is wanted is the recovery of a spiritual outlook on life, the practical application of the Golden Rule in all our affairs. There is too much narrow nationalism to-day and not enough inter-nationalism. We shall never find salvation through selfishness. We shall never find salvation through conquest, only through contact and mutual service.

"We will recover before long, especially if we all co-operate to that end. The old saying, 'Heaven helps those who help themselves,' has got to be revised to 'Heaven helps those who help each other.' I believe it is through mutual co-operation that we are going to find our way out.

"Mr. President, may we of the Gas Industry on both sides of the great ocean on whose historic shores we stand to-day—by cultivating in all our relations with the public and with each other the true spirit of friendship, goodwill, and co-operation; and by carrying that further, individually and collectively, into all our international relationships—play our part, wisely and bravely, in bringing about the elevation of all human transactions to the higher plane on which, and on which alone, can dwell lasting peace and true prosperity."

[The photograph that we are able to reproduce of Mr. Paige and his guest leaving the Convention Hall after they had delivered their addresses shows that they, at any rate, felt pleased to have "got it over"—in more senses than one of that phrase!]

On the Threshold of Great and Glorious Things.

Apart from the General Session on Tuesday at which this address was given, Sir Francis attended and spoke at the Session of the Home Service Section on the Monday afternoon and of the Commercial Section on the Wednesday. At the last mentioned, very interesting papers were read by Hall M. Henry, of New York, on "Surmounting Competition in the Domestic Cooking and Water Heating Fields," which faced facts fully and fearlessly and showed courage, initiative, and faith in dealing with them; and by H. S. Christman, of Philadelphia, on "Gas Refrigeration," which told a wonderful story of the development of gas consumption in that field. The concluding paragraphs of Mr. Christman's paper are worth quoting and noting.

"The Gas Industry has had a wonderful past. I firmly believe it has a far more wonderful future ahead. That may seem a rash prediction in the midst of these dark days right now. But this belief is based upon past experience. Look back over the past ten years and what do you find? The birth of many marvellous new inventions and ideas. What helped these ideas to be born? The depression of 1921. Adversity somehow seems to sharpen our wits and our ingenuity. This nation thrives on a fight against odds. It came into being as the result of such a fight. We grew as our forefathers fought their way westward against trackless wilderness. We are a fighting nation, and I do not mean in a military sense so much as in an economic way.

"Out of the depression of 1921 came the tremendous rise of the radio, the stupendous growth of talking pictures, the spread of commercial airlines, the beginning of television.

"I believe that we, the Gas Industry, are on the threshold of great and glorious things in the decade to come, and that the gas refrigerator, with its tiny gas flame, will help us light the way to that future. The surface has merely been scratched in the field of automatic refrigeration. And there are other developments in sight, which the gas refrigerator is going to hasten. Air conditioning for the home, for instance. A thing of such tremendous possibilities for the gas industry that it staggers the imagination. Yet something that is bound to come, and probably sooner than any of us expect. Within our own time we will sit in our homes on a hot sultry night, every window closed, yet surrounded by clean, cool air. On a cold winter night, we will also be perfectly comfortable, in the midst of warm filtered air that is neither too hot nor too dry. And the marvel that will both cool the air in summer and warm it in winter will be gas.

"Truly, 'the old order changeth, yielding place to the new.'"

It can be readily understood that these two papers gave Sir Francis plenty of text for the impromptu address with which he concluded an inspiring Session, crowded with an audience which gave him another splendid reception.

The impression we get from all the reports that have reached us is that much good has been done to the cause of friendship and co-operation between not only the gas industries but the nations on both sides of the Atlantic by the visits to Atlantic City and to Canada this year by Mr. Herbert Canning and Sir Francis Goodenough, representing the one the technical and the other the commercial sides of our Industry, and we hope that these visits will lead to others by other leaders in the coming years.

The fact that Sir Francis was entertained by groups of representative business men and bankers in New York, Washington, Boston, Toronto, and Quebec; had the privilege of addressing the English-Speaking Union as their guest in the first three of those cities; and, last but not least, had the honour of a lengthy interview with President Hoover at the White House, is cause for gratification to the Gas Industry as well as to Sir Francis (who tells us that he had "a most wonderful time all through"), but can only be recorded here in bare outline.

New Gasholder Completed at Bridport

The centenary year of the Bridport Gas Company was marked by the construction of a new gasholder, the erection of which was skilfully carried out by Messrs. S. Cutler & Sons, of Millwall, London

A new gasholder has just been completed at the works of the Bridport Gas Company, Ltd., and it is now in full operation supplying gas to the town.

This latest addition to the Company's plant is 72 ft. in diameter and 60 ft. high, with a capacity of 150,000 c.ft., and forms an important landmark. Its erection fittingly coincides with the centenary of the undertaking, gas being first introduced into Bridport in the year 1831.

"The Dorset County Chronicle" of that year contains the following reference:

"The Gas-Works are in an active state of progress, the first fire was lit under the retorts on Friday last. The Neath Abbey Company under the superintendence of Mr. Tregilles, Engineer, carried out the work of constructing the works.

"No sooner was the lighting begun on Monday, than people crowded the streets to witness the commencement of its beautiful appearance, and all ranks were seen participating in the joy which it created. The Bridport Band added to the enlivening scene.

"The only shop or private dwelling which was ready for the reception of the gas was that of Dr. Roberts who is but less celebrated for every means which tends to advance the comfort and happiness of his fellow creatures, than for his well-known medicine called 'Poor Man's Friend.' This otherwise excellent and well arranged establishment in the centre of the town was liberally illuminated and attracted the attention of the crowd assembled in the street. Indeed it is but justice to this spirited and scientific individual to say that the speedy accomplishment of the gas light is partly owing to his exertions."

A Century of Progress.

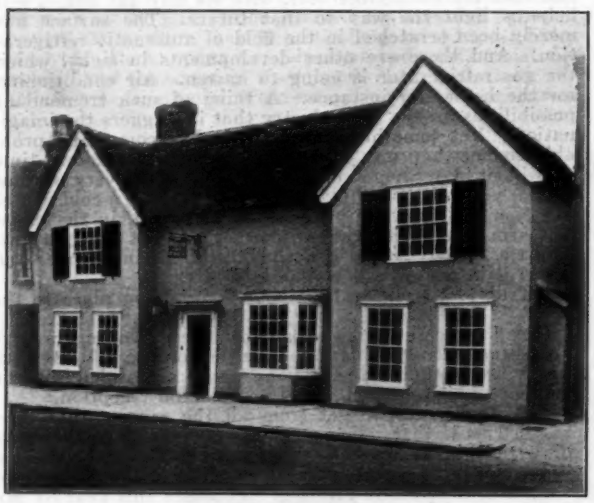
Throughout the years of the succeeding century, the history of this undertaking has been marked more or less by continued progress, especially during the last 25 years.

The Directors of the Bridport Gas Company, states the "Bridport News," commenting upon the completion of the new holder, are to be congratulated on their foresight and business acumen in providing such a useful addition to their plant, the whole of which has been carried out under the supervision of the Company's Engineer, Manager, and Secretary, Mr. W. H. Reid.

A NEW WINDOW IN - BILLERICAY -

Conversion of a Fifteenth Century House into attractive Showroom by the Gas Light and Coke Company

For the first time those who live in and around that charming Essex village of Billericay can now see for themselves how much gas means to the modern home. By the conversion of a fine old fifteenth century house, known as "The Gables," in the High Street into up-to-date gas showrooms, the Gas Light and Coke Company, far from spoiling the old-world atmosphere of the village street, have definitely added to its amenities.



Fifteenth Century House at Billericay converted into Showrooms by the Gas Light and Coke Company.

This historic old building has been redecorated both inside and out and attractively furnished within in the usual dignified and characteristic style so well known in the Company's larger showrooms nearer the Metropolis. The result is that the interior has now become eminently suitable for the display of the representative selection of gas appliances to be seen there. Small as the showrooms are compared with many of the Company's premises, yet there is no suggestion of their being cramped: there is a complete bathroom and hot water section, a wide range of cookers, attractive gas fires in suitable surrounds, and one of the most modern open coke fires in action. Special importance is attached to showing the very best and most beautiful lighting fittings; for Billericay, as yet, has not suffered from the ravages of electricity. It is therefore the very commendable policy of the Company to supply all with the very best gas lighting fittings, with distance control.

Behind the showroom is a small office for the clerical staff attached to the district, while an extensive and well-kept garden stretches away at the back. The front of the building is finished in yellow plaster, with green window edging, while an attractive gas lantern beside the entrance is in keeping with the general style.

Opening Ceremony.

The opening ceremony of these new showrooms was performed on Monday, Nov. 2, by Mr. F. W. Price, Chairman of the Great Burstead Parish Council, who was supported by Mrs. Price, other members of the Council, and prominent local residents. Representing the Gas Light and Coke Company were Sir David Milne-Watson (Governor), Mr. R. W. Foot (General Manager), Mr. W. L. Galbraith (Secretary), Mr. Thomas Hardie (Chief Engineer), together with senior Officers of the Gas Sales Department.

Sir David Milne-Watson presented Mr. Price with a silver key, with which he opened the showrooms, remarking that it gave him very great pleasure to do so.

After an inspection of the premises, an adjournment was made to the Women's Institute Hall, where tea was served at the invitation of the Gas Light and Coke Company—Sir David Milne-Watson presiding.

At the conclusion of tea, Sir David said that it gave him very great pleasure to see so many present on the occasion of the opening of these new showrooms in Billericay; and he was very pleased that the Chairman of the Parish Council had been able to come and declare the premises open. This was a new venture on the part of the Gas Light and Coke Company. They had pursued a policy of opening new and up-to-date showrooms all over London, some on a very large scale.

But when they came to Billericay they felt that to put up anything new and ostentatious would be out of keeping with the character of a country town such as this. Fortunately they were architecturally in the hands of a very capable man—Mr. Walter Tapper, a man very high up in his profession—who appreciated what was old and beautiful; so that when he was called in to advise he suggested that they should leave this beautiful old house unspoiled—with all the charm of a country house. By having regard to the local amenities of the town they did very wisely, and he ventured to think they would get more business from the inhabitants through these premises than if they had put up something glaring.

Sir David referred to the size and activities of the Gas Light and Coke Company, remarking that it now extended from Windsor to Southend—an enormous stretch of territory extending all along the north bank of the Thames; and they supplied gas to the smallest domestic user and to the largest industrial consumers. Billericay was not at the moment an industrial town, but should it become such in the future, gas would be there to assist them.

In conclusion, Sir David said that they were very glad indeed to have come into the village, and they hoped to bring with them good service, because the Company always tried to do its best for its customers; they had set a high ideal in that respect, and they wanted to give all that was required in the way of efficient service. He finally thanked Mr. Price very much for coming to declare their new premises open.

A Compliment to Billericay.

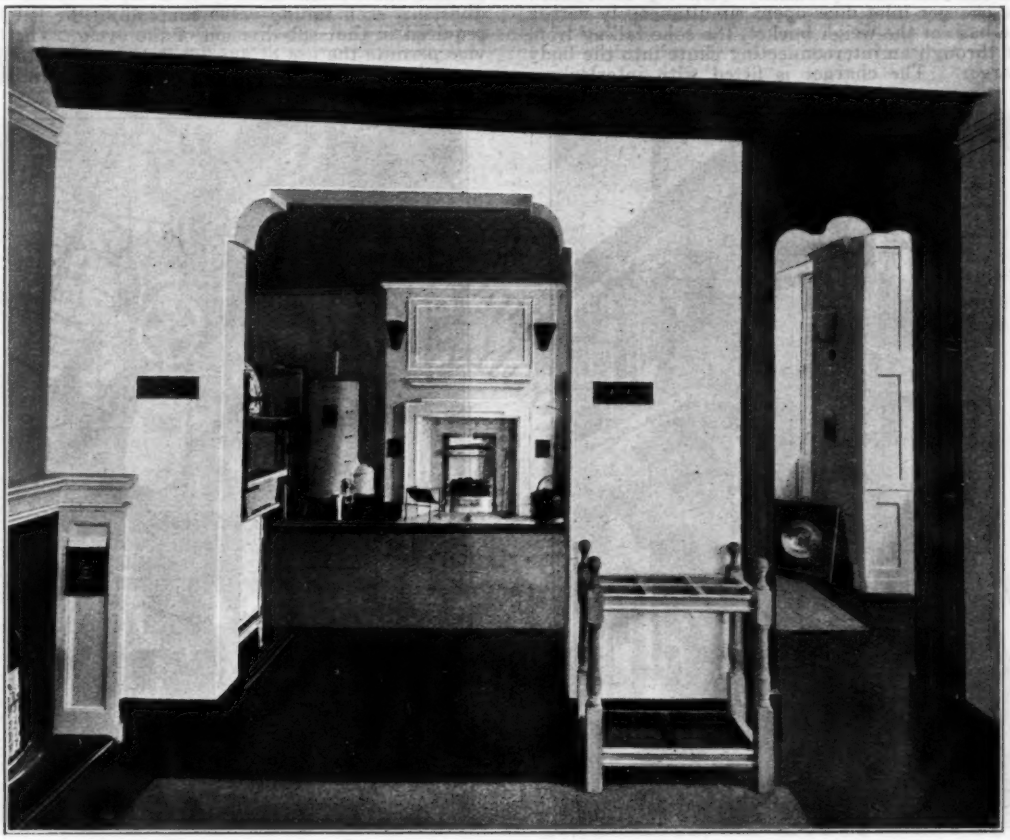
Mr. F. W. Price said that as Chairman of the Parish Council he would like to extend a hearty welcome to all those present on that occasion. It was a great compliment to have Sir David in Billericay that day, and he congratulated the Gas Light and Coke Company on their conversion of this historic building. They had been very anxious in the district for a long time in regard to what was going to happen to this building, and they were relieved to learn that the original structure was to remain. He hoped that the venture would meet with the sucess it deserved. Many had benefitted by the advent of the Gas Light and Coke Company to the district.

The Opening Ceremony of the Gas Light and Coke Company's Showrooms at Billericay.

Left to right: Sir David Milne-Watson, D.L., LL.D. (Governor of the Company); Mr. F. W. Price (Chairman of the Great Burstead Parish Council); Mrs. Price; and Mr. R. W. Foot (General Manager of the Company).

In conclusion, Mr. Price thanked the Company for the honour done him in his being asked to declare the new showrooms open.

The accompanying photograph illustrates the very attractive result of the conversion of the fifteenth century building into a gas showroom, making a building well worthy of the town in which, in its original form, it has already stood so long.



A CORNER OF THE GAS LIGHT AND COKE COMPANY'S BILLERICAY SHOWROOMS.

The late fifteenth century oak opening on the right was discovered in the wall.

AUTOMATIC WATER GAS PRODUCTION

Description of the A.B.C. Self-Clinkering Grate, Howard Automatic Charger, and Western Automatic Control

Recently we inspected one unit of a large blue water gas installation which Messrs. Davison & Partner, Ltd., have in hand for abroad. The installation consists of four 12 ft. diameter fully-automatic units equipped with waste-heat boilers, coke conveying plant, &c., each capable of producing from 3½ to 4 million c.ft. daily. The plant is being constructed by Messrs. Newton Chambers & Co., of Sheffield, who are also building the A.B.C. mechanical self-clinkering grates which form part of the equipment. Each generator is complete with Western automatic control and Howard automatic charger.

The A.B.C. Grate.

The A.B.C. grate is flat, and over it revolves a hollow, water-cooled, cast-steel beam about 15 in. high, arranged with its forward or working face both up-stroking and out-stroking. Means are provided by which the rate of rotation of the beam can be varied from 30 to 427 minutes per revolution, 13 different speeds being available. The up-stroking action of the beam produces a wave-like motion in the fuel bed which is most decided in the immediate vicinity of the beam and gradually diminishes to nothing about 5 ft. above the grate. This is the function of the beam which is so important in maintaining horizontal uniformity in the fuel bed.

The out-stroking action of the beam accomplishes four distinct objects. The first is that the ash is pushed into an annular compartment, which is closed to the flow of gas. The ash is removed from this compartment periodically. The operator may adjust the ash removal so as to maintain a clean active fire bed and yet have the carbon loss at a minimum by regulating the speed of the beam. After once being adjusted to any particular fuel, very little attention, we understand, is required to maintain this condition.

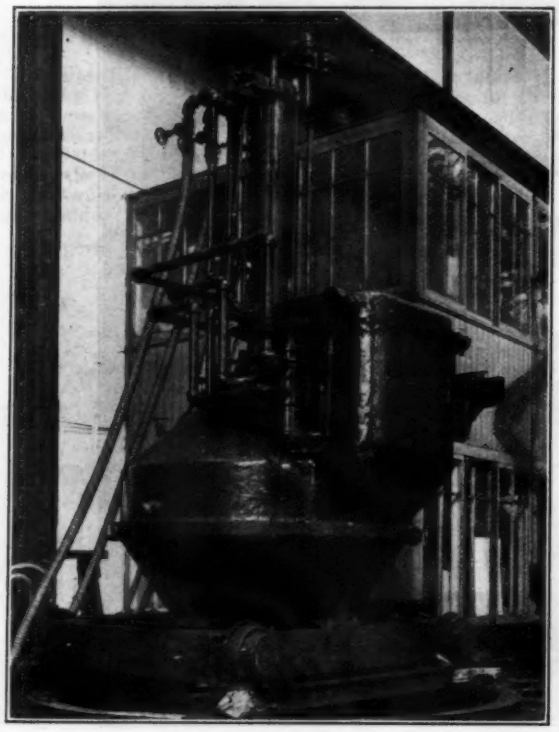
The second function performed by the out-stroking action of the beam is the packing of the fuel against the wall, thus preventing channeling of the blast along the wall with consequent excessive temperature and the formation of wall clinker. The third object attained is the boring out of the centre of the fire bed, thus keeping it in a loosened, active condition. Fourth, should clinkers be formed, the beam crushes them.

The beam rotates on a ball race, and thus the power required to operate it is small. The robust driving gear is clearly shown in one of the photographs we reproduce; it is a simple matter to unbolt the whole gear, *en bloc*, from the generator, should this become necessary.

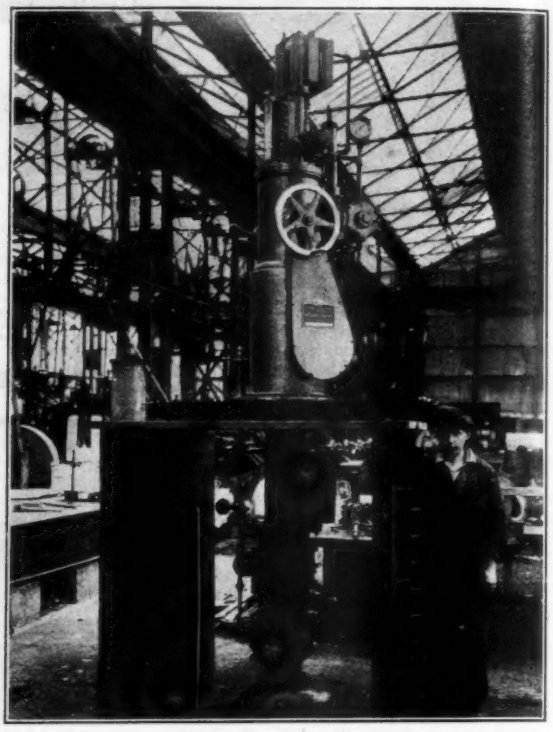
Howard Automatic Charger.

We also reproduce a photograph of the Howard automatic charger with which the plant is equipped. This charger is mounted on a truck which runs on a track, so that the machine may easily be moved away from the top of the generator. During each " down-run " make period, a " spreader " valve in the base of the charger automatically opens and feeds the generator with a definite weight of coke, at the same time opening a discharge " gate " on the main coke bunker. Coke from this bunker falls into a balanced " weigh bucket " situated above the charger. When the desired weight of coke has passed into the bucket, this tips slightly down and automatically closes the main bunker gate, the charger spreader valve being closed by the

automatic controller independently. During each blow period, the charger inlet door opens simultaneously with a slide in the base of the weigh bucket, the coke falling from the bucket through an interconnecting chute into the body of the charger. The charger is fitted with interlocking gear which definitely prevents the spreader valve and the inlet door from opening together.



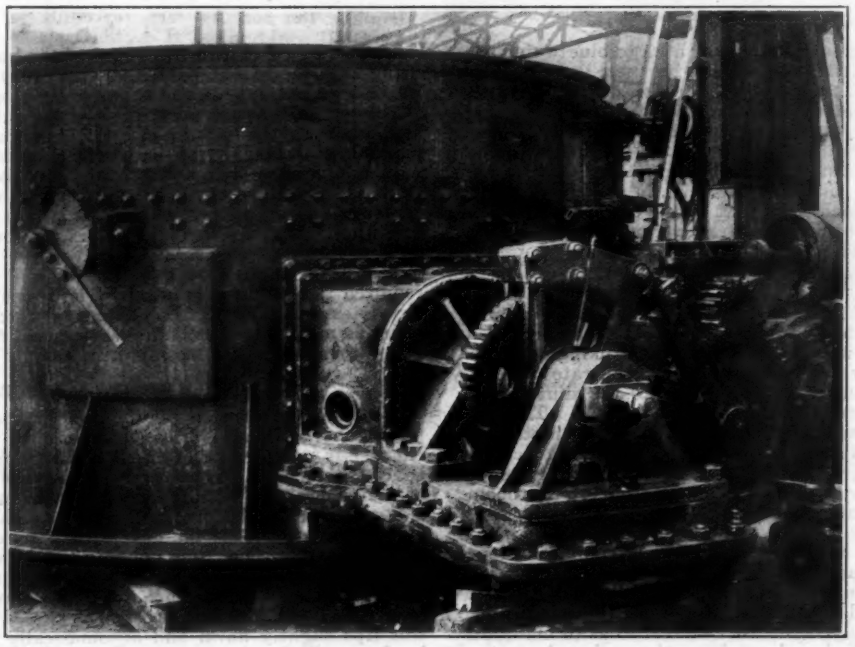
Howard Automatic Charger.



The "Mechanical Man."
(Western Automatic Control.)

The "Mechanical Man."

Finally, we come to the Western automatic control—aptly termed the "mechanical man." Rugged in design, this control is operated entirely with oil under pressure supplied by a motor-driven centrifugal pump. Constant pressure of the oil is maintained through the adaptation of a mercury regulator in the supply line from the pump to the control. Timing valves are provided on the control to govern the cycle. The cycle is split up in short sub-divisions, each timing valve controlling the length of time required in that sub-division of the cycle. The timing device permits the use of any length of cycle required in the operation of the generating set. It also permits the division of the cycle into the blow and run periods with any desired percentage in each step. Within the range of cycles per hour commonly used, it is possible to vary the length of cycle without changing the make-up—that is, the percentage of blow in proportion to the run can be maintained even though the total cycle is varied. The proportion of the blow to the run can also be changed by adjusting the timing valves in the division requiring change and adding or deducting this time to or from the remaining divisions.



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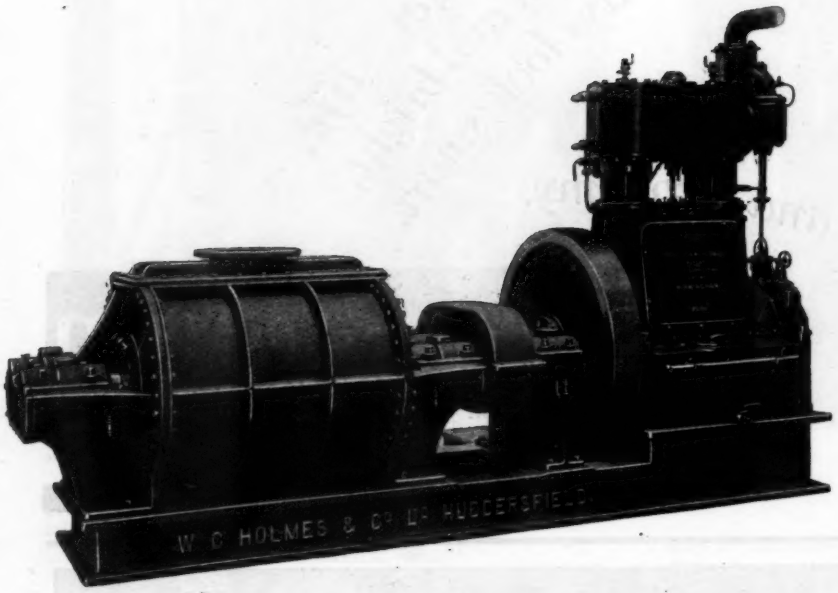
Telegrams: STRUCTURE, STRETFORD.

CONNERSVILLE BOOSTERS



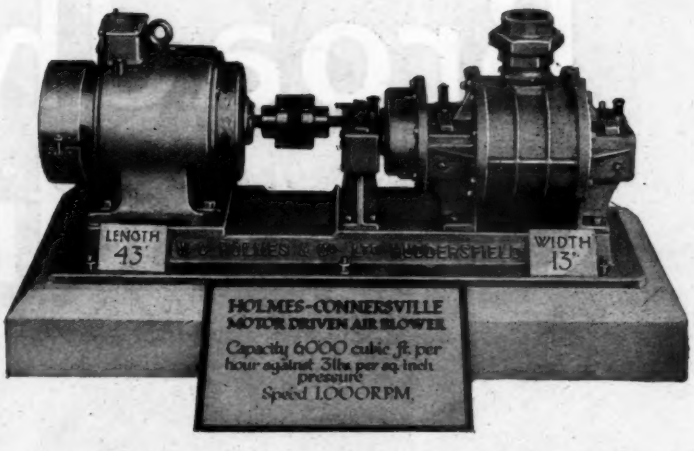
CONNERSVILLE BOOSTERS ARE POSITIVE AND DEPENDABLE

THEY SAVE POWER AND MAINTENANCE COSTS

Direct coupled to modern steam engines of high efficiency or electric motors.

Some Recent Installations of HOLMES "CONNERSVILLE" Exhausters, Boosters and Air Blowers.

- Gas Light & Coke Co., Kensal Green.
- Ipswich Gas Light Co.
- Maidstone Gas Co.
- Notts & Derby Coke and By-Product Co., per Coppee Co.
- Perth Corp. Gas Dept., Australia, per W. Coward & Co.
- Tottenham & District Gas Co.
- Tunbridge Wells Gas Co.
- York Gas Co., per Drakes Ltd.
- Gosport District Gas Co.
- Walton-on-Thames & Weybridge Gas Co.
- South Suburban Gas Co., per Drakes Ltd.
- Thorncliffe Coal Distillation Ltd., Sheffield.
- Herne Bay Gas Co., Ltd.


LENGTH 43"
WIDTH 13"
HOLMES-CONNERSVILLE MOTOR DRIVEN AIR BLOWER
Capacity 6000 cubic ft. per hour against 3lbs. per sq. inch pressure
Speed 1000 R.P.M.

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THE EFFLUENT
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The "K.E." PATENT
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PLANT

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THE MANCHESTER
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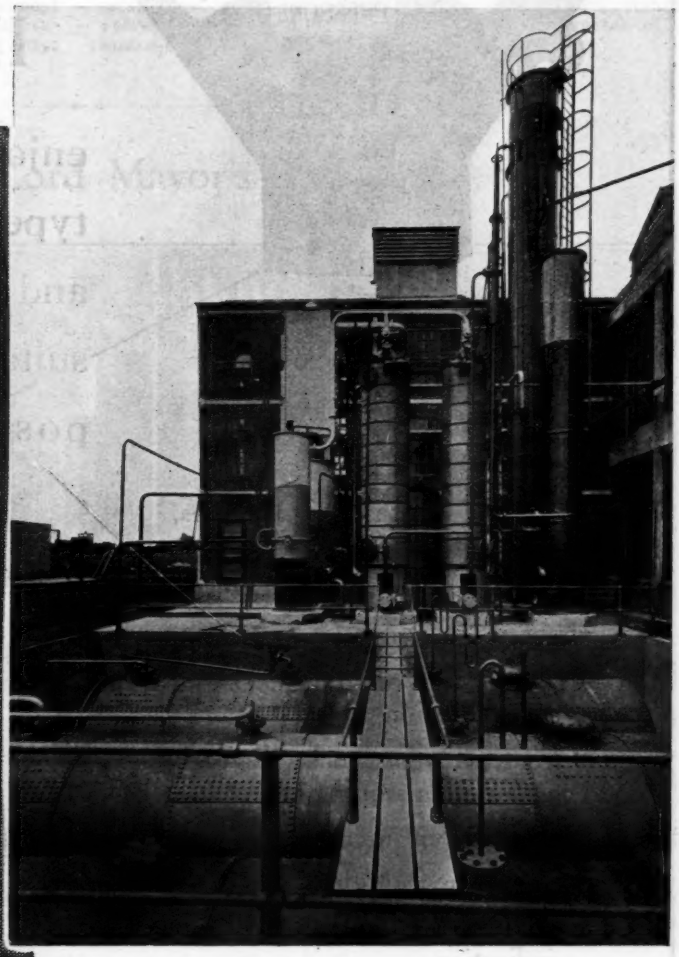

British Patent Nos. 175,985, *July* 10, 1923. 230,705, *March* 19, 1925. 249,411, *Oct.* 14, 1926

★ HOLMES SPECIAL PROCESSES & PLANT INCLUDE:—

"SUPER-TYPE" CONDENSERS.
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CENTRIFUGAL GAS WASHERS.
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BENZOL PLANTS FOR PRODUCING MOTOR SPIRIT.
AMMONIA DISTILLING PLANTS.
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—and these are the reasons why

The Simmance Patent

DEAD-BEAT INDICATOR

enjoys dominion over other types of pressure gauge; and why it is particularly suitable for all the purposes of a Gasworks.

- Flexible metal diaphragms, resistant to corrosion.
- Lever transmission to pointer.
- Gravity control of movement.
- Provision for re-adjustment and re-calibration.
- Two-way vent cock, zero-adjuster and damping valve.
- Robust cast-iron case.
- Large open-scale dial.
- Instantaneous and dead-beat indication.
- No levels to read, no glasses to clean or replace.

"READ THE PRESSURE BY THE POINTER."

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These adjustments can all be made while the control is in operation. This gives complete flexibility and perfect control of the cycle.

An indicator scale is provided on the control showing the various divisions of the cycle. An indicator travelling over these divisions shows not only the progress of the cycle, but also the progress at that stage of the cycle, showing when the various valves will function.

A run counter is placed on the indicator scale showing the number of runs made. In this way an accurate record is made of the runs, eliminating the necessity of writing down the record of operation. With this device the operator can, in case of hand operating, determine when the charging period is at hand, thus permitting him to devote his attention to other details.

A by-pass line is provided between the top and bottom of the pressure cylinder, enabling the operator instantly to stop the control by opening the by-pass valve. With the by-pass open the operator can use the handwheel to control the set as desired. The set can be operated by hand as long as required, and automatic operation can be resumed at will by closing the by-pass valve. Complete hand operation of the set is accomplished by using the handwheel only. By opening this by-pass valve the control can be stopped in any part of the cycle, and that stage of the cycle can be lengthened by allowing the control to remain idle. On the other hand, any stage of the cycle can be shortened by opening the by-pass valve and, with the aid of the handwheel, moving the control ahead in the cycle. This in no way interferes with the time the cycle is set for. Upon resuming automatic operation, the cycle will be exactly the same as before.

Very few working or moving parts are incorporated in the control, making for simplicity, ease of operation and low maintenance cost. The control, as can be seen from our picture, stands in a vertical position, having a neat appearance and taking up a minimum amount of space on the operating floor.

The power cylinder is located below the charging floor and contains a hollow piston valve floating up and down and which opens and closes the ports, directing high and low water pressure to the cylinders on the valves. The master cylinder controls any valves required on the various sets; blast valves, reversing valve, stack valve, steam valves, oil valves, and turbine valve or power switch of a motor-driven blower.

Gas in the Lord Mayor's Show

We were glad to see that gas played its part in this year's Lord Mayor's Show by two striking lorry displays by the Gas Light and Coke Company. As will be seen from the accompanying photographs various phases of gas service, domestic and industrial, were portrayed. Immediately behind and extending in part over the driver's cab of each lorry was a representation of a waterless gasholder painted in dark green. The display on the domestic side showed gas for the kitchen, the bathroom, and for laundry purposes, while the slogan, "7,000,000 British Homes Use Gas for Cooking," on the side of the lorry was impressive propaganda. On the second lorry gas was shown in its industrial application with the striking message that "2000 London Industries Use Gas for Heat Processes." The lorries were finished in an attractive colour scheme, and at the four corners of each were flambeaux fittings with the word "GAS" above them. The Gas Light and Coke Company are to be congratulated upon the use made of this valuable opportunity of bringing gas prominently before the public eye.

A COKE FIRE

By A. F. DUFTON, M.A., D.I.C.

The Author describes a coke grate of his own design, and its working

In the leading article in "Nature" for Oct. 17 the support of scientific workers in the prevention of atmospheric pollution was demanded, and it was suggested that observations made in their private capacity when adopting the smokeless methods of heating would materially assist in the improvement of the quality of the smokeless fuels. There seems to be some doubt as to what constitutes a satisfactory fuel. In the article in "Nature" the statements are made that the production of a satisfactory fuel is still in an experimental stage and that the production of these fuels at a popular price has yet to be achieved, its actual possibility being openly challenged in some quarters. The important fact that gas coke is a highly satisfactory fuel for an open fire would appear to have escaped notice.

Some years ago the author designed the coke-grate shown in figs. 1 and 2, which was made by a village blacksmith for ten shillings. It is a tripod, and the back leg fits into a short iron tube cemented into the hearth. This grate has been in use for three winters and has given great satisfaction. It is thought that a record of the behaviour of the

Fig. 1.—The Grate.

Fig. 2.—A Coke Fire.

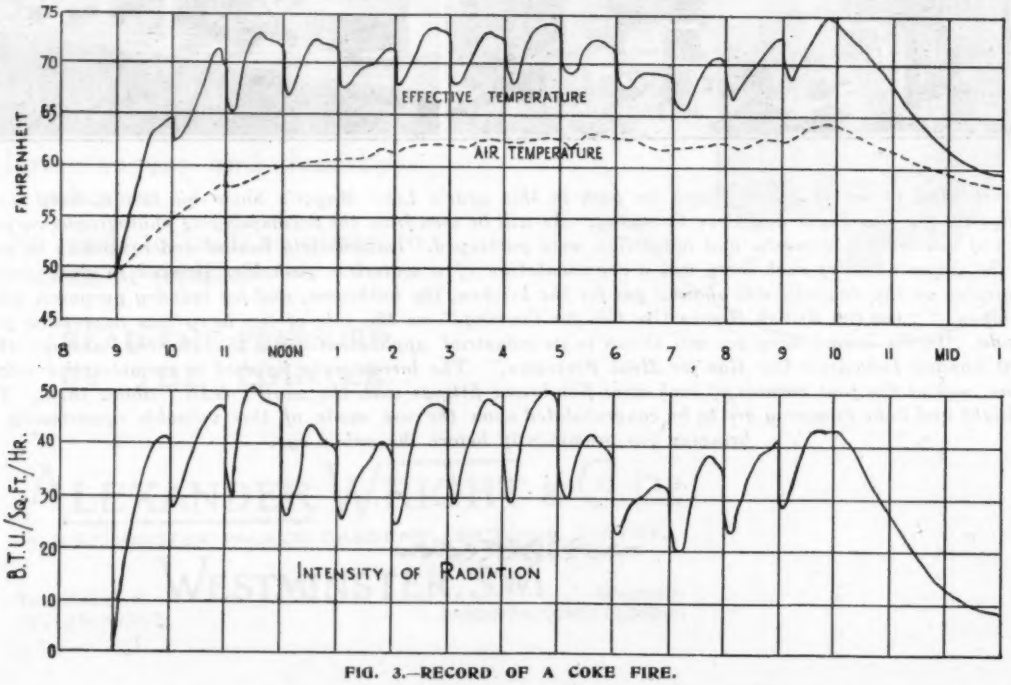

FIG. 3.—RECORD OF A COKE FIRE.

fire on a February day, when the average outside temperature (from midnight to midnight) was 37° Fahr., may interest those who have not had the opportunity of appreciating a coke fire.

The reports of the Fuel Research Board, by their emphasis on standard conditions of test, leave the impression that coke is difficult to ignite, that the use of gas is necessary, and that the coke should be carefully graded. The coke used by the author is gas coke. It is stored in the open, exposed to the weather, and varies in size more than do potatoes. The fire is lighted with wood, just like a coal fire, and the draught is increased for a few minutes at the start by holding a newspaper, or preferably a " blower " of sheet iron, in front of the fire.

The fire of which the record is shown in fig. 3 was laid with newspaper, 1¾ lbs. of wood, and 4 lbs. of dry coke (the residue from the previous fire). It was lit at 9 a.m. and 7 lbs. of coke were added in the first ten minutes. The fire was stoked regularly, 2 lbs. of coke being added every hour. It was not poked until 7 p.m., when it was seen to be burning rather slowly owing to a slight accumulation of ash. The fire was not stoked after 9 p.m. On the next morning, 4 lbs. of dry coke were recovered. The ash was collected and found to weigh 1¾ lbs.—6 p.ct. of the weight of coke consumed.

Fig. 3 shows the air temperature in the centre of the room, measured at a height of 3 ft. 3 in., and also the effective temperature[1] 8 ft. in front of the centre of the fire. The average effective temperature from 9 a.m. to midnight was 69° Fahr., and the average air temperature was 61° Fahr. It has been shown from the cumulative results of a number of observations[2] that in a similar room, with a mean outside temperature of 40° Fahr., the combustion of 3 lbs. of coal per hour over a sixteen-hour day results in a mean air temperature of approximately 58°. It is clear that much more warmth is obtained from 2 lbs. of coke efficiently burned than from 3 lbs. of coal.

The lower half of fig. 3 is a record of the intensity of radiation at a distance of 8 ft. from the fire. This record was obtained with a thermopile which was calibrated by means of a Bone-Callendar-Yates bolometer. The record shows the mean intensity to be 36 B.Th.U. per sq. ft. per hour, which is as great as the value found for a coal fire burning 3 lbs. of coal per hour[3].

Although the records were taken at only one position, it is quite clear that the room, which has a capacity of 1800 c.ft. and is exposed on three walls, was thoroughly and efficiently warmed. The room is on the ground floor and there is no room above it: the ceiling is of lath and plaster and is not boarded above the joists. The cost of the 29 lbs. of coke used was sixpence, so that the cost of a good coke fire is under one-halfpenny an hour.

Among other points, attention may perhaps be drawn to the fact that a very much more intense fire than the one described can be obtained by increasing the amount of fuel in the grate. Within five minutes of lighting the fire is radiant and it is possible to toast bread; if the fire gets low, it is readily resuscitated by means of the blower; and by making it up with ash to reduce the rate of burning, it is possible to keep the fire in for six or seven hours without attention.

It is conceded that gas coke from different sources varies greatly in quality, inferior coke being difficult to ignite; but all the coke which has been tried has been usable. When the type required is pointed out to a coal merchant, there should be no difficulty in obtaining satisfactory supplies.

[1] Phil. Mag. 1930, **9** (59), 858.

[2] Department of Scientific and Industrial Research. Fuel Research. Technical Paper No. 12, p. 37.

[3] *Ibid*, p. 38.

Parliamentary Intelligence

[From Our Special Correspondents.]

House of Commons.

Special Orders.

Plans have been deposited in accordance with the Gas Undertakings Acts, 1920 and 1929, in respect of the following Special Orders: Bideford; Nantwich; Shanklin and Ventnor; South Yorkshire and Derbyshire.

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GAS MANTEL REGISTERS *for* Modern Housing Requirements

Fitted with seven radiants, all interior parts, easily removable, complete with brass inlet tap, fitted with gas and air adjustor, etc.

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No. 1296G Gas Mantel Register.

REGISTER OF PATENTS

Sulphate of Ammonia Manufacture.—No. 356,283.

HODSMAN, H. J., of Leeds, and TAYLOR, A., of Hull.

No. 9542; May 30, 1930.

According to this invention, sulphate of ammonia is manufactured by bringing an aqueous solution containing ammonium sulphite into contact with an oxidizing gas so as partly to oxidize the ammonium sulphite, and then completing the oxidation electrolytically so as to produce a solution of sulphate of ammonia.

Crude ammonia liquor may be combined with sulphur dioxide which may be supplied in excess. This sulphur dioxide may be obtained by burning sulphur, or materials containing sulphur, by known methods, or may be wholly or in part derived from the flue gases of steam boilers or other furnaces when these gases contain sulphur dioxide.

Oxidation of the resulting ammonium sulphate liquor is then commenced by the action of hot gases containing free oxygen, and for this purpose the sulphite liquor may be allowed to pass down a suitably packed tower or through an equivalent plant where it is subjected to a current of hot oxygen-containing gases, such as products of combustion containing free oxygen. In this way oxidation of the sulphite takes place, and the bulk of the liquor is reduced by evaporation, while the phenols, if present, are largely driven off. As the liquor becomes more and more concentrated the rate of oxidation decreases, but it is possible for the sulphite to be about half converted to sulphate, while the volume of liquor may at the same time be reduced to a fraction of its original volume.

The completion of the oxidation of the ammonium sulphite liquor is then effected in an electrolytic cell, and the efficiency of this operation is increased by the ammonium chloride already present in the liquor, while, if necessary, chloride may be added.

The electrolysis is arrested before the thiocyanate or thiosulphate, if present, is oxidized. The oxidized liquor may now be evaporated by known methods to obtain a commercial crystallized salt of ammonia, consisting mainly of sulphate with some chloride. The mother liquor, containing thiocyanate and thiosulphate of ammonia, can be disposed of by known methods.

The oxidation of the ammonium sulphite by the action of the oxygen-containing gases may be accelerated by the employment of a catalyst.

Gas Fires.—No. 355,998.

CLARK, T., of Kildare Terrace, London, W. 2.

No. 29,973; Oct. 7, 1930.

This invention consists of a metal duct made to any suitable size to fit the back of a gas fire. Near the top of the duct a metal division is fitted that divides the duct into two chambers, the upper forming a ventilating chamber and the lower being traversed by the hot gases from the gas stove. The products of combustion are carried into the duct and pass through the lower chamber. The gases leave through the lower hole of the back plate which is fixed in the recess of grate, the heat being radiated off into the room by means of the duct. The air in the room is free to pass through the upper duct opening in the lid. The valve in the lid of the upper chamber is open for ventilation purposes only.

Prepayment Mechanism.—No. 356,382.

WEST, A. J., and the GAS METER COMPANY, LTD., both of Kingsland Road, London, E. 2.

No. 21,324; July 14, 1930.

This invention relates to prepayment mechanisms of the kind wherein a lever mounted upon a rotary coin holder is moved into engagement with a toothed wheel after insertion of a coin and patrial rotation of the holder. In such mechanisms, when desired to change from the employment of coins of one denomination to coins of a different denomination, it has been usual, state the patentees, to provide screws for association with the rotary coin holder and with the movable member mounted thereon, which screws may be inserted or removed. Such measure, although effective in achieving the desired result, involves the expenditure of time which may be objectionable, and it also involves the risk of failure due to the inadvertent manipulation of one screw only. This invention aims at providing a device whereby the time involved in making the change is greatly reduced and whereby the risk of only partially completed manipulation is entirely removed. The invention consists in the provision of two pins adapted to be brought axially into required position in the coin slot or removed therefrom at will, and locked in either position by a spring device. The pins are carried upon members the axial movement of which can only be effected simultaneously.

During partial rotation of the rotary coin holder, relative radial movement can take place between the pins. The latter are carried upon separate mutually pivoted arms axially movable upon a guide rigid with rotary coin holder.

Gas Fire Radiants.—No. 354,795.

FORSHAW, A., of Falkirk, R. & A. MAIN, LTD., of Westminster, and VAN GELDEREN, F. M., of Enschede.

No. 14,892; May 14, 1930.

According to this invention a radiant for a gas fire is characterized in that the projections are so shaped and disposed in relation to the apertures in the wall of the radiant and to the direction of the flow of gases through the radiant as to direct a part of the gases from the interior to the exterior thereof. Preferably, each projection is arranged above an aperture in the back wall of the radiant and is inclined downwardly as it extends inwardly away from the aperture.

A feature of the invention consists in that the apertures in the rear wall of the radiant are triangular in configuration, and in that the apex of each triangle is directed downwardly, and in that the projections extend from the base of the triangle inwardly towards the centre of the radiant.

The invention also includes a method of manufacturing a radiant for a gas fire, which method consists in forming a tubular element from a plastic refractory material, and piercing the material while still plastic at a number of different locations with a spear-shaped tool by laying the blade of the tool against the plastic material and swinging the point of the tool inwardly about a transverse axis disposed near the base of the head of the tool. The projections on the front wall of the radiant are preferably formed along lines which represent ribs of a skeleton structure to be formed, and the material is cut away on either side of the ribs while the material is still plastic.

A feature of this method consists in that the plastic tubular member is formed by casting a clay slip in a porous mould (*e.g.*, a plaster-of-paris mould), allowing the slip to solidify on the surface of the mould for a period of time, according to the thickness required for the tubular element, and thereafter draining the remaining fluid slip from said mould and finally baking said tubular element after the projections and apertures have been formed.

Levelling Bars for Coke Ovens.—No. 356,063.

GAS CHAMBERS AND COKE OVENS, LTD., and BOWATER, N. J., both of Westminster.

No. 34,044; Nov. 12, 1930.

This invention relates to levelling bars employed for levelling the charge of coal in the coking chambers. The object is to provide a levelling bar which will exert a compacting action on the fuel, thus dispensing with or assisting stamping or ramming of the charge of fuel, which for some kinds of fuel promotes the formation of good quality coke. For this purpose a levelling bar is provided at close intervals along its operative length with massive rollers rotating about horizontal axes, in substitution for, or in addition to, the usual transverse distance bars. These rollers, by rolling on the upper surface of the fuel in the coking chamber, not only level off the surface of the fuel but also crush down and compact the fuel.

Prepayment Meters.—No. 354,797.

UNITED GAS INDUSTRIES, LTD., of Lincoln's Inn Fields, W.C. 2, SIMPSON, S., of Exmouth, SMITH, E. W., of Kennington Park Road, S.E. 11, and ROBINSON, S., of Liverpool.

No. 4787; Feb. 12, 1930.

This invention relates to prepayment mechanism, and has among its objects to adapt such mechanism for operation by coins of more than one value by means that do not require the addition, removal, or substitution of any parts of the mechanism to cause the change in the gear ratio according to the value of the coin intended to be used; and to provide simple means for the purpose adapted by a single adjustment to render the mechanism operable in the use of the intended coin, and generally to improve the construction and operation of prepayment mechanism of gas and similar meters adapted for use with coins of more than one value.

Carburetted Water Gas.—No. 354,650.

HUMPHREYS & GLASGOW, LTD., of Westminster (Assignees of PERRY, J. A., of Swarthmore, Pennsylvania).

No. 34,177; Nov. 13, 1930. Convention date, Dec. 19, 1929.

The following claim is made for this invention: A process for the manufacture of mixed hydrocarbon gas and water gas wherein re-formed hydrocarbon gas is produced by cracking in an ignited fuel bed hydrocarbon gas from an extraneous source, and water gas is produced by steaming the fuel bed, and these gases are passed through a carburetting vessel or vessels. The re-formed hydrocarbon gas is carburetted with oil so that a stiff pitch from the hydrocarbon gas becomes mixed with fluid tar from the carburetting oil, which mixture is easily removable from the washboxes or other accessory apparatus.

STOCK AND SHARE LIST.

[For Stock Market Report, see earlier pages.]

Issue.	Share.	When ex-Dividend.	Dividends. Prev. Hf. Yr.	Dividends. Last Hf. Yr.	NAME.	Quotations. Nov. 7. (Provincial Exchanges Nov. 6.)	Rise or Fall on Week.	Transactions. Lowest and Highest Prices During the Week.
£			% p.a.	% p.a.				
1,551,868	Stk.	Oct. 5	7⅞	7⅞	Alliance & Dublin Ord. ...	100—105	...	102½—103
374,000	,,	July 9	4	4	Do. 4 p.c. Deb.	67—72	...	...
522,655	,,	Aug. 24	7	7	Barnet Ord. 7 p.c. ...	121—126	...	...
300,000	1	Oct. 19	1/9⅜	1/4⅛	Bombay, Ltd.	15/—17/6	...	17/-
174,500	10	Aug. 10	9	9	Bournemouth 5 p.c. ...	14⅜—15⅜	...	...
500,050	10	,,	7	7	Do. B 7 p.c. ...	12—13	...	...
489,160	10	,,	6	6	Do. Pref. 6 p.c. ...	10½—11½	...	...
50,000	Stk.	June 25	3	3	Do. 3 p.c. Deb. ...	55—60	...	...
162,025	,,	,,	4	4	Do. 4 p.c. Deb. ...	75—80	...	...
357,300	,,	Aug. 24	7½	7½	Brighton & Hove 6 p.c. Con.	114—119	...	...
371,880	,,	,,	6¾	6¾	Do. 5 p.c. Con.	104—107	...	...
1,287,500	,,	July 23	5	5	Bristol 5 p.c. max.	90—93[a]	...	...
120,420	,,	June 25	4	4	Do. 1st 4 p.c. Deb.	78—80[a]	...	...
217,870	,,	,,	4	4	Do. 2nd 4 p.c. Deb. ...	78—80[a]	...	...
328,790	,,	,,	5	5	Do. 5 p.c. Deb.	98½—99½[a]	...	...
855,000	,,	Oct. 5	8	7	British Ord.	108—113	...	110—111
100,000	,,	June 25	7	7	Do. 7 p.c. Pref. ...	110—115	...	110
120,000	,,	,,	4	4	Do. 4 p.c. Red. Deb. ...	70—75	...	73
450,000	,,	,,	5	5	Do. 5 p.c. Red. Deb. ...	92—97	...	...
160,000	,,	June 25	5	5	Cambridge 5 p.c. Deb. ...	95—100	...	...
100,000	10	May 21	6	8	Cape Town, Ltd.	9—10	...	...
100,000	10	Oct. 30	4½	4½	Do. 4½ p.c. Pref. ...	6½—7¼*	...	...
150,000	Stk.	June 25	4½	4½	Do. 4½ p.c. Deb. ...	65—70	...	68—70
626,860	,,	July 23	6	6	Cardiff Con. Ord. ...	95—98	...	...
237,860	,,	June 25	—	2¾	Do. 5 p.c. Red. Deb.	90—95	...	...
157,150	,,	Aug. 10	6½	5	Chester 5 p.c. Ord. ...	85—90[b]	...	...
98,936	1	Oct. 5	†2/-	2/-	Colombo, Ltd. Ord.... ...	27/—32/-	...	...
24,500	1	,,	1/4¼	1/4¼	Do. 7 p.c. Pref.	17/—19/-	...	...
609,204	1	Oct. 19	1/3·27	-/10·90	Colonial Gas Assn. Ltd. Ord.	7/6—12/6	...	...
296,053	1	,,	1/5·67	1/2·54	Do. 8 p.c. Pref.	10/—15/-	...	...
2,078,280	Stk.	July 23	6	6	Commercial Ord.	92—95	...	93—94
475,000	,,	June 11	3	3	Do. 3 p.c. Deb. ...	52—57	...	...
787,560	,,	Aug. 10	7	7	Croydon sliding scale	107—110	...	109
458,100	,,	,,	5	5	Do. max. div. ...	81—84	...	82—83½
542,270	,,	Aug. 24	10	7	Derby Con.	120—125[c]	...	...
55,000	,,	June 25	4	4	Do. Deb.	65—70[c]	...	...
209,000	,,	Sept. 7	5	5	East Hull Ord. 5 p.c. ...	70—73	...	...
1,002,180	,,	Sept. 21	†4½	†4	European, Ltd.	100—110	...	100—103½
18,953,033	,,	July 23	5⅝	5⅝	Gas Light & Coke 4 p.c. Ord.	18/9—19/9/	+·/3	19/1¼—19/6
2,600,000	,,	,,	3½	3½	Do. 3½ p.c. max. ...	55—60	...	56—59
4,294,691	,,	,,	4	4	Do. 4 p.c. Con. Pref. ...	74—79	...	74½—75½
5,694,095	,,	June 11	3	3	Do. 3 p.c. Con. Deb. ...	56—61	...	58½—60
3,642,770	,,	,,	5	5	Do. 5 p.c. Red. Deb. ...	98—102	...	100⅜—101
2,500,000	,,	,,	—	4½	Do. 4½ p.c. Red. Deb. ...	89—94	...	91½—93
161,480	,,	Sept. 7	10	10	Harrogate Cons. 10 p.c. max.	157—162	...	...
82,500	,,	Aug. 24	7	7	Hastings & St. L. 5 p.c. Conv.	95—100	...	99½
258,740	,,	,,	5½	5½	Do. 3½ p.c. Conv.	80—85	...	84½
70,000	10	9 Oct. '30	‡	10	Hongkong & China, Ltd. ...	12½—13½	...	...
213,200	Stk.	Aug. 10	6	6	Hornsey Con. 3½ p.c. ...	89—92	...	...
2,800,000	,,	Oct. 30	25	15	Imperial Continental Cap.	345—365*	...	347—353
223,130	,,	Aug. 10	3½	3½	Do. 3½ p.c. Red. Deb.	70—75	...	...
235,242	,,	Aug. 10	8½	8½	Lea Bridge 5 p.c. Ord. ...	129—132	...	...
2,145,907	,,	Aug. 24	6	6	Liverpool 5 p.c. Ord. ...	95—96[b]	+1	...
306,083	,,	July 15	4	4	Do. 4 p.c. Deb. ...	79—81[b]	...	...
165,736	,,	Aug. 24	9	8	Maidstone 5 p.c. Cap. ...	123—128	...	...
63,480	,,	June 25	3	3	Do. 3 p.c. Deb. ...	55—60	...	...
75,000	5	June 11	†10	†10	Malta & Mediterranean ... Metropolitan (of Melbourne)	6¾—7¼	...	...
392,000	—	Oct. 1	5½	5½	5½ p.c. Red. Deb.	78—83	...	...
171,978	Stk.	Aug. 24	5	5	M. S. D. Utility "C." Cons.	76—81	...	...
522,992	,,	,,	4	4	Do. 4 p.c. Cons. Pref.	67—72	...	...
675,000	,,	May 21	†6	†6	Montevideo, Ltd.	70—80	...	...
2,061,315	,,	Aug. 10	5⅛	5	Newcastle & Gateshead Con.	15/6—16/64/	+·/3	...
682,856	,,	,,	4	4	Do. 4 p.c. Pref. ...	69—71[d]	...	...
691,705	,,	June 25	3½	3½	Do. 3½ p.c. Deb. ...	69—71[d]	...	...
277,285	,,	Oct. 30	5	5	Do. 5 p.c. Red. Deb.	96—98[d]	−2	...
199,940	,,	Aug. 24	7½	7½	North Middlesex 6 p.c. Con.	105—110	...	...
396,160	,,	Aug. 10	5	5	Northampton 5 p.c. max. ...	74—79	...	...
300,000	,,	Apl. 23	9	7	Oriental, Ltd.	93—103	...	93—94
60,000	5	13 May, '15	—	—	Ottoman	0—¼	...	...
205,162	Stk.	June 25	8	8	Plym'th & Stonehouse 5 p.c.	110—115	...	...
424,416	,,	Aug. 24	8	8	Portsm'th Con. Stk. 4 p.c. Std.	119—124	...	...
241,446	,,	,,	5	5	Do. 5 p.c. max. ...	76—79	...	...
686,312	,,	July 23	4	4	Primitiva 4 p.c. Rd. Db. 1911	83—86	...	...
389,813	,,	June 25	4	4	Do. 4 p.c. Cons. Deb.	84—87	...	...
150,000	10	Sept. 21	6	6	San Paulo 6 p.c. Pref. ...	7⅞—8	...	...
1,736,968	Stk.	Sept. 7	6⅜	6	Sheffield Cons.	103—105[e]	...	...
95,000	,,	July 9	4	4	Do. 4 p.c. Deb.	79—81[e]	...	...
133,201	,,	Sept. 7	5	5¼	Shrewsbury 5 p.c. Ord. ...	72—77	...	...
90,000	10	June 11	†5	†5	South African	3½—5½	...	...
6,709,895	Stk.	July 23	7½	5	South Met. Ord.	99—102	...	100—102
1,155,812	,,	,,	6	6	Do. 6 p.c. Irred. Pf.	102—107	+2	103½—106
1,895,445	,,	July 9	3	3	Do. 3 p.c. Deb. ...	56—61	...	...
1,000,000	,,	July 23	4	3	Do. 5 p.c. Red. Deb.	95—100	...	98
91,500	,,	Aug. 10	8½	8½	South Shields Con.	108—110[d]	...	...
1,543,795	,,	Aug. 10	6½	6½	South Suburban Ord. 5 p.c.	101—104	...	103½
668,837	,,	June 25	5	5	Do. 5 p.c. Deb.	92—97	...	...
647,740	,,	Aug. 24	5	5	Southampt'n Ord. 5 p.c. max.	76—79	...	...
121,275	,,	June 25	4	4	Do. 4 p.c. Deb.	70—75	...	...
250,003	,,	Aug. 24	7	7	Swansea 7 p.c. Red. Pref. ...	95—98	...	...
200,000	,,	June 25	6½	6½	Do. 6½ p.c. Red. Deb.	99—102	...	100½—101½
1,076,490	,,	Aug. 10	6⅜	6⅜	Tottenham and District Ord.	103—107	...	104½—106
150,000	,,	,,	5½	5½	Do. 5½ p.c. Pref. ...	93—98	...	...
199,005	,,	June 11	4	4	Do. 4 p.c. Deb. ...	70—75	...	...
85,701	,,	Sept. 21	6	6	Tuscan, Ltd., 6 p.c. Red. Db.	72—77	...	...
310,694	,,	Aug. 24	7	7	Uxbridge, Maidenhead, & Wycombe 5 p.c.	100—105	...	103½—104½
88,330	,,	,,	5	5	Do. 5 p.c. Pref. ...	88—93	...	...
1,322,220	,,	July 9	7	7	Wandsworth and District: Consolidated	111—114	...	111½—112
971,373	,,	,,	5	5	Do. 5 p.c. Pref.	90—95	...	95
1,167,964	,,	June 25	5	5	Do. 5 p.c. Deb.	93—98	...	97

Quotations at:—*a.*—Bristol. *b.*—Liverpool. *c.*—Nottingham. *d.*—Newcastle. *e.*—Sheffield. *f.*—The quotation is per £1 of stock. * Ex. div. † Paid free of income-tax. ‡ For year. § Div. = 10 p.ct. p.a. less tax and less tax on interim dividend.

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GAS MARKETS & MANUFACTURES

Stock Market Report.

[For Stock and Share List, see earlier page.]

A cheerful atmosphere prevailed in most sections of the Stock Exchange last week. That confidence is returning may be evidenced by the steady stream of buying orders, particularly of British Funds, by small investors. Business, moreover, was by no means confined to this section, for Industrials also had a large following; and the optimism in this department is justified by the reports which have been circulated with regard to the definite increase in trade in many directions during the past few weeks. Subject, therefore, to the necessary prompt remedial measures being taken by the Government, the outlook is brighter than has been the case for a very long time past.

Business in Gas stocks and shares was quite satisfactory, and the highest prices of recorded transactions were in many instances a trifle above last week's best. Apart from one *ex* div. reduction, there were only four changes in the quotations—all improvements—viz., Gas Light and Newcastle £1 units, both of which advanced 3d., the former to 19s. 3d., and the latter to 16s. at the local Exchange, while South Metropolitan 6 p.c. preference rose 2 points to 104½.

Those investors who, after a long period of waiting, are now coming into the market in the hope of making quick profits will seldom find an outlet for their activities in the Gas Section; but for those who require securities of a purely investment character to give a fair and steady yield this department provides particularly good opportunities. This is well illustrated by the following table, which shows the yields on some of the larger ordinary issues at the current prices based on last year's dividends:

—	Present Price.	Dividend 1930.	Yield. P.Ct. per Annum.
		P.Ct.	£ s. d.
Alliance and Dublin	102½	£7 12s. 6d.	7 8 9
Bristol	91½*	5	5 9 3
Commercial	93½	6	6 8 4
Gas Light £1 units	19s. 3d.	£5 12s.	5 16 4
Liverpool	95½*	6	6 5 7
Newcastle £1 units	16s.	£5 7s. 6d.	6 14 4
Sheffield	104*	6½	6 5 0
South Metropolitan	100½	6¼	6 4 4
South Suburban	102½	6½	6 6 9
Tottenham	105	£6 12s. 6d.	6 6 2
Wandsworth	112½	7	6 4 5

* At the local Exchange.

The dividends for the past half-year were all at the same rates as in 1930, except in the case of the Tottenham Company which increased its distribution by 2s. 6d. p.ct. per annum, while the Sheffield interim dividend was reduced from 6½ p.ct. to 6 p.ct. per annum.

Current Sales of Gas Products.

The London Market for Tar and Tar Products.

LONDON, *Nov.* 9.

Tar products continue firm. Current values are as under:

Pitch continues to advance, and is from 65s. to 70s. per ton f.o.b.

Creosote, for export, varies from 3¾d. to 5d. per gallon f.o.b., according to specification.

Pure toluole is firm at about 2s. 3d. per gallon; benzole is about 1s. 6d. to 1s. 7d. per gallon; 95/160 solvent naphtha, about 1s. 5d. to 1s. 6d. per gallon; and pyridine bases, 3s. 3d. to 3s. 6d. per gallon.

Tar Products in the Provinces.

Nov. 9.

The average prices of gas-works products during the week were: Gas-works tar, 22s. to 26s. Pitch—East Coast, 55s. to 56s. f.o.b. West Coast—Manchester, Liverpool, Clyde, 55s. to 56s. f.o.b.* Toluole, naked, North, 1s. 8d. to 1s. 8½d. Coal-tar crude naphtha, in bulk, North, 5d. to 5½d. Solvent naphtha, naked, North, 1s. 3d. to 1s. 3½d. Heavy naphtha, North, 11d. to 11½d. Creosote, *ex* works, in bulk, North, liquid and salty, 3½d. to 3¾d.; low gravity, 1¼d.; Scotland, 3¼d. to 3½d. Heavy oils, in bulk, North, 5d. to 5½d. Carbolic acid, 60's, 1s. 6½d. to 1s. 7d. Naphthalene, £9 to £10. Salts, 50s. to 70s., bags included. Anthracene, "A" quality, 2½d. per minimum 40 p.ct., purely nominal; "B" quality, unsaleable.

* All prices for pitch are now quoted on the basis of f.o.b. In order to arrive at the f.a.s. value at any port it will be necessary to deduct the loading costs and the tolls whatever they may be.

Tar Products in Scotland.

GLASGOW, *Nov.* 7.

Conditions remain steady in this area with inquiries for forward delivery quite numerous. Stocks continue low, however, so that business is difficult.

Pitch.—With supplies scarce quotations have increased to 57s. 6d. to 60s. per ton f.o.b. Glasgow for export, and about 57s. 6d. per ton *ex* works for home trade.

Refined tar to Ministry of Transport Specification is now higher at 3½d. to 3¾d. per gallon *ex* makers' works in buyers' packages.

Creosote oil.—Quotations are unchanged. B.E.S.A. Specification is 2¾d. to 3d. per gallon; low gravity, 3¼d. to 3½d. per gallon; and neutral oil, 3¼d. to 3½d. per gallon—all f.o.r. makers' works.

Cresylic acid.—Business is slow, and prices are unchanged. Pale, 97/99 p.ct., 1s. 3d. to 1s. 4d. per gallon; dark, 97/99 p.ct., 1s. 2d. to 1s. 3d. per gallon; and pale, 99/100 p.ct., 1s. 5d. to 1s. 6d. per gallon—all f.o.r. in reasonable quantities.

Crude naphtha.—Production is low, and value is steady at 4½d. to 5d. per gallon, according to quality.

Solvent naphtha.—Few orders are being placed, but quotations are steady. 90/160 is 1s. 3d. to 1s. 4d. per gallon, and 90/190, 1s. to 1s. 1d. per gallon.

Motor benzole is quiet at 1s. 3d. to 1s. 4d. per gallon *ex* works in bulk quantities.

Pyridines.—90/160 grade is 3s. to 3s. 8d. per gallon; and 90/140 grade, 3s. 3d. to 3s. 6d. per gallon.

Benzole Prices.

These are considered to be the market prices for benzole at the present time:

	s. d.		s. d.	
Crude benzole	0 7	to	0 7½	per gallon at works
Motor ,,	1 2	,,	1 3	,, ,, ,,
Pure ,,	1 6	,,	1 7	,, ,, ,,

Contracts Advertised To-Day.

Boiler House and Mess Room and Laboratory.

The Oldham Corporation invite tenders in connection with the above. [Advert. on p. 439.]

Coal.

The Clacton Urban District Gas Department invite tenders for the supply and delivery of coal. [Advert. on p. 439.]

Gasholder Repairs and Re-sheeting.

The Gainsborough Urban District Gas Department invite tenders for repairing and re-sheeting of a gasholder. [Advert. on p. 439.]

Trade Notes.

"Denso-Cord."

We have received from Messrs. Paul Winn & Co., Ltd., of 40, Trinity Square, E.C. 3, a leaflet describing a new material for pipes of which they are the sole agents for the British Isles and Colonies. Denso-Cord, state the agents, is a permanently plastic gas and water-tight jointing material which will withstand vibration and is not acted upon by any constituent of the gas and water supply. It supplies a feature previously lacking—namely, a joint secure against vibration and corrosion, which will remain permanently gas-tight in spite of modern traffic conditions.

CONTENTS

EDITORIAL NOTES.

A GLANCE AT THE CONTENTS . . . 471
A Little Help— 472
Opportunity Brings Responsibility . . . 472
On Behalf of the Small Undertakings . . 472
Virtues of Special Tariffs 472
The Load Factor 473
Co-Operation 473
Here and There 474

CORRESPONDENCE.

Institution Autumn Research Meeting . . 474
Diploma in Gas Supply 474
Low-Temperature Carbonization 474
Gas Publicity in Barbados 475

Personal 475
Forthcoming Engagements 477

NEWS OF THE WEEK.

Paragraphs 476
Institution of Gas Engineers 476
Eltham Council Tenants and Gas—Will the Ban be Removed? 476
National Gas Council—Meeting of Central Executive Board 476
Coal-Fired Furnaces Supplanted by Gas . . 477

NEWS OF THE WEEK—(*continued*).

Recent Developments in Cooking Apparatus—Gas Makes the Biggest Advance . . . 477
Portsmouth Girl's Success in "Fairy Gas" Competition 477
The Chester United Gas Company . . . 478
Pictorial Proof 478
A Talk on Gas at Rotary Club 478
Steady Progress of Barnet Undertaking . . 478
Gas and Coke Interests in the Canadian Provinces during 1930 478
Bath Gas Company's Development . . . 479

SPECIAL ARTICLES, &c.

In Continental Countries—Abstract Translations from the Technical Press of France and Germany 479
Floodlighting by Gas at Barking 480
Gas Companies' Protection Association—Thirty-Fourth Annual General Meeting . 481
An Outside View of the Gas Industry. By Major G. H. Kitson 484
New Retort Installation at Newcastle-under-Lyme 486
New Members of the Institution 487

"JOURNAL" TECHNICAL RECORD.

Midland Association of Gas Engineers and Managers—
General Business 488
Water Heating by Gas. By J. H. Paterson 488

"JOURNAL" TECHNICAL RECORD—(*continued*).

Institution of Gas Engineers—
Contribution to the Discussion on the First Report of The Street Lighting Committee 491
Manufacture of Solid-Drawn Steel Tubes . 491
Scottish Junior Gas Association (Western District)—
Presidential Address of Mr. Alexander McDonald, B.Sc., A.I.C., A.R.T.C. . . 492
Wales and Monmouthshire Junior Gas Association—
Visit to the Water Pumping Station at Blaenclydach 494
Presidential Address of Mr. S. E. Brett . 494
London and Southern District Junior Gas Association—
Visit to the Southall Gas-Works . . . 495
Progress of Pipe Joint Research. By K. R. Knapp 496
Notes on Plants and Processes 497

MISCELLANEOUS.

Trade Notes 496
Parliamentary Intelligence 497
Gas Undertakings' Results 498

GAS MARKETS AND MANUFACTURES.

Stock Market Report 498
Current Sales of Gas Products 498
Contracts Advertised To-Day 498
New Capital Issues 498

Stock and Share List 499

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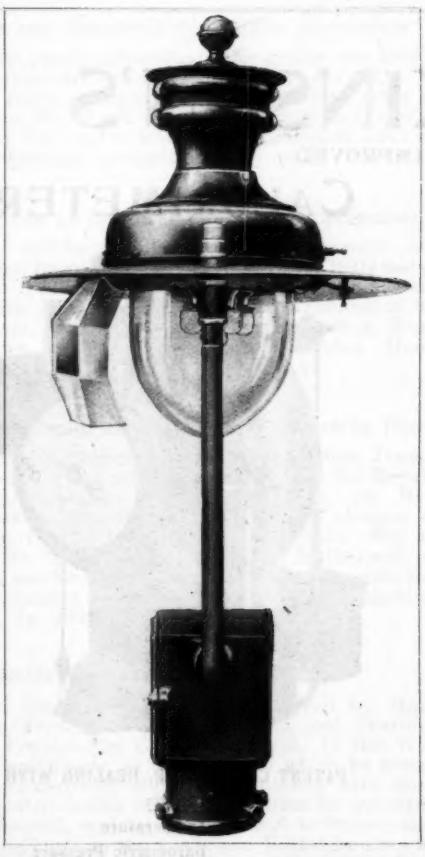

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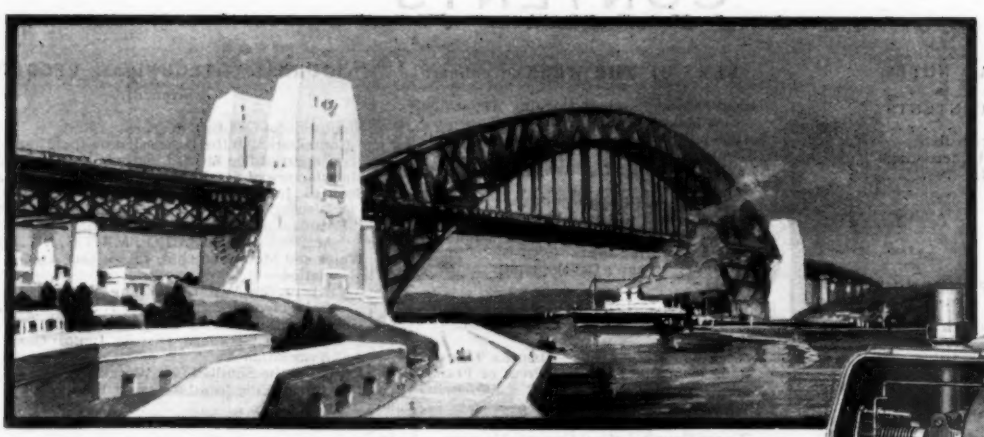

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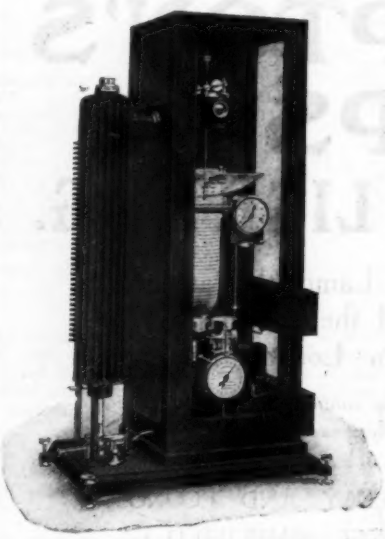

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